

DEVELOPMENT OF A SATELLITE-BASED GROUND COVER CLASSIFICATION PROGRAM FOR ALBERTA

**Part of the Earth Observation Pilot Projects Program (EOP3)
Canada Centre for Remote Sensing**

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EXECUTIVE SUMMARY

The Earth Observation Pilot Projects Program (EOP3) is one of several initiatives in Canada's Long Term Space Plan (LTSP) aimed at promoting remote sensing applications and technology transfer and training. The EOP3 initiative is designed to encourage Canadian resource management agencies and industry to use data from earth observation satellites for operational purposes.

Through the auspices of the Canada Centre for Remote Sensing (CCRS), EOP3 projects have been initiated in a number of provinces including Alberta. One of the principal objectives of the Alberta EOP3 initiative was to develop a multi-user, ground cover classification scheme to be applied province-wide, and suitable for a broad range of Alberta Environmental Protection (AEP) needs. The Alberta program was geared to meeting regional needs pertaining to vegetation mapping, wildlife habitat assessment, forest fuel mapping, and the need to monitor long-term landscape change.

The Alberta EOP3 classification scheme emphasizes forest and other vegetation communities and considers Natural Region differences. The primary data source was Landsat TM satellite imagery, coupled with other ancillary including Alberta Vegetation Inventory (AVI) data, digital elevation data, province-wide 1:50 000 digital Land Use/Access data, and black and white aerial photographs.

Satellite imagery was selected for the Northwest and Northeast Boreal Regions, Northeast Slopes and Southeast Slopes Regions, and Parkland and Prairie Regions in consideration of regional needs and priority sites identified by regional staff. One NTS map sheet was selected for classification purposes for the Northeast Boreal, Northeast Slopes, Parkland and Prairie Regions whereas two NTS map sheets were selected for the Northwest Boreal and Southeast Slopes due to the size of the areas involved. Map sheets were selected from previously identified regional priority sites.

The Alberta EOP3 Ground Cover Classification Scheme was developed in consideration of AEP's request for 1:50 000 scale mapping to meet regional needs and to provide linkages with other Alberta mapping initiatives. The latter was particularly important to ensure EOP3 products would nest hierarchically with other province-wide mapping initiatives, notably 1:100 000 Reconnaissance Vegetation Inventory (RVI) mapping, 1:20 000 AVI mapping and 1:20 000 ecological mapping currently underway for most of Alberta's Southeast Slopes Region.

The classification scheme developed by Anderson et al. 1976, and the more recent scheme developed by Russell (1986) for Alberta Fish and Wildlife Division were used to help shape the Alberta EOP3 ground cover scheme. The national vegetation scheme developed by the National Vegetation Working Group of the Canadian Committee for Ecological Land Classification (Strong et al. 1990) also was used. All three schemes are hierarchical and have

four to five principal levels in the hierarchy. Five principal categories were identified in the EOP3 scheme including: 1) anthropogenic; 2) uplands; 3) wetlands and water; 4) barren lands; and 5) unclassified. Details of the scheme are provided in Appendix 1.

Ground cover was classified using a four step process including image rectification, image stratification, image classification and image interpretation. Image stratification and classification were undertaken using ISODATA clustering techniques. This is an iterative process used to progressively discriminate natural spectral differences and to aggregate spectral data into appropriate ground cover classes. Image interpretation is accomplished by visual examination and class conflicts manually interpreted and edited using ancillary data. Image analysis was undertaken PCI EASI/PACE software. Appendix 2 provides a summary of image analysis procedures.

Geographic Information System (GIS) technology was used to combine classified imagery for priority sites with other geographically referenced data to produce maps of EOP3 ground covers and Fire Behaviour Prediction (FBP) fuel types. GIS work was completed using ESRI's ArcView software. A manual of GIS mapping procedures is included as Appendix 3.

Results of the program were encouraging. A minimum acceptable overall map accuracy is 80%, and a minimum acceptable accuracy for any one ground cover is greater than 65%. Overall accuracies for all regions were greater than 85%, with one exception the Southeast Slopes, where an overall accuracy of 83.8% was achieved. This could have been substantially improved if ancillary data had included more than AVI data. Interpreted airphotos and appropriately referenced permanent sample plot data would have been beneficial.

Overall accuracies were greatest for the Parkland Region (93.7%) due to a high degree of GAIA staff familiarity with the region's vegetation, quality of the interpreted airphotos, and input from regional staff. Overall accuracies also were high for the Northwest Boreal Region, Quarter Scene 46-19 (91.2%), the result of two field trips to the area to resolve wetland ground covers. These results demonstrate the need for adequate ancillary data for image stratification, classification, and interpretation. Similar programs conducted elsewhere in the province, should wherever possible, allocate sufficient time and money to collecting site-specific ground truth data.

Costs to complete a similar program elsewhere in the province for six, 1:50 000 NTS map are estimated at \$50 000 in professional fees, exclusive of costs to purchase satellite imagery, airphotos, and to stage a program of field reconnaissance.

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Alberta Ground Cover Classification, NTS Mapsheet 84 J/13
Alberta FBP Fuel Type Classification, NTS Mapsheet 84 J/13

Northeast Boreal Region

Alberta Ground Cover Classification, NTS Mapsheet 83 I/7
Alberta FBP Fuel Type Classification, NTS Mapsheet 83 I/7

Northeast Slopes Region

Landsat TM Image of 83 L/5

Southeast Slopes Region

Alberta Ground Cover Classification, NTS Mapsheet 82 J/10
Alberta FBP Fuel Type Classification, NTS Mapsheet 82 J/10
Alberta Ground Cover Classification, NTS Mapsheet 82 J/15
Alberta FBP Fuel Type Classification, NTS Mapsheet 82 J/15

Parkland Region

Alberta Ground Cover Classification, NTS Mapsheet 82 P/15
Alberta FBP Fuel Type Classification, NTS Mapsheet 82 P/15

Prairie Region

Alberta Ground Cover Classification, NTS Mapsheet 72 E/2
Alberta FBP Fuel Type Classification, NTS Mapsheet 72 E/2

1.0 INTRODUCTION

1.1 Project Background

The Earth Observation Pilot Projects Program (EOP3) is one of several initiatives in Canada's Long Term Space Plan (LTSP) aimed at promoting remote sensing applications and technology transfer and training. The EOP3 initiative is designed to encourage Canadian resource management agencies and industry to use data from earth observation satellites for operational purposes, as well as to help Canadian remote sensing companies develop and demonstrate their technical expertise.

Through the auspices of the Canada Centre for Remote Sensing (CCRS), EOP3 projects have been initiated in a number of provinces, e.g., Nova Scotia, British Columbia and Alberta. The objectives of the program are different in each province depending on the needs of the resource agency for whom the work is being conducted.

In Alberta, one of the principal objectives of the EOP3 initiative was to develop a multi-user, ground cover classification scheme to be applied province-wide, and suitable for a variety of Alberta Environmental Protection (AEP) needs. The classification program addressed medium to small scale mapping requirements for reconnaissance purposes. Information products were generated at a scale of 1:50,000.

The classification scheme emphasized forest and other vegetation communities and considered Natural Region differences. The primary data source was Landsat TM satellite imagery, coupled with other ancillary including Alberta Vegetation Inventory (AVI) data, digital elevation data, province-wide 1:50 000 digital Land Use/Access data, and black and white aerial photographs.

The Alberta program was geared to meeting regional needs pertaining to vegetation mapping, wildlife habitat assessment, forest fuel mapping, and the need to monitor long-term landscape change.

A second objective was implementation of a technology transfer program to develop in-house geomatics expertise among Alberta Environmental Protection staff. This was undertaken to encourage the use of geomatics technology for answering complex environmental management issues and for developing a greater synergy among various mapping projects and programs.

2.0 APPROACH

2.1 Selection of Priority Sites

Satellite imagery was selected for the Northwest and Northeast Boreal Regions, Northeast Slopes and Southeast Slopes Regions, and Parkland and Prairie Regions in consideration of regional needs and priority sites identified by regional staff (Figure 1).)

One NTS map sheet was selected for classification purposes for the Northeast Boreal, Northeast Slopes, Parkland and Prairie Regions, whereas two NTS map sheets were selected for the Northwest Boreal and Southeast Slopes due to the size of the areas involved. Map sheets were selected from previously identified regional priority sites. Table 1 details the satellite scenes used for each region and associated NTS map sheets classified for each region.

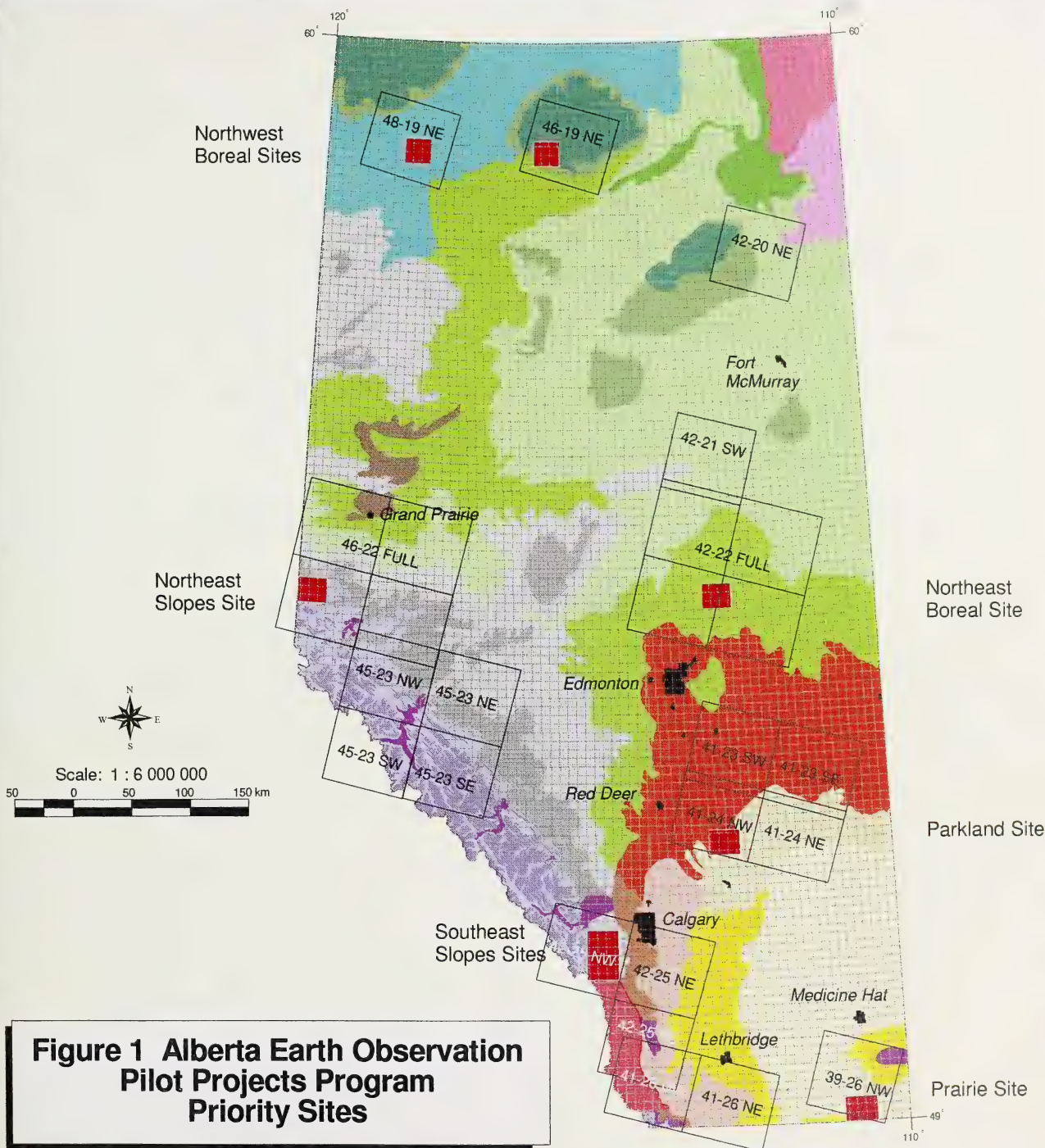
Table 1.
Landsat TM Scenes Used for Each Region and Associated NTS Map Sheets
Classified for Each Region.

Region	Satellite Scenes Used	Classified Mapsheets
Northwest Boreal	Path 48, Row 19, NE Quadrant Path 46, Row 19, NE Quadrant	84 L/16 84 J/13
Northeast Boreal	Path 42, Row 22, SW & SE Quadrants	83 I/7
Northeast Slopes	Path 46, Row 22, SW Quadrant	83 L/5*
Southeast Slopes	Path 42, Row 25, NW Quadrant	82 J/10, 82 J/15
Parkland	Path 41, Row 24, NW Quadrant	82 P/15
Prairie	Path 39, Row 26, NW Quadrant	72 E/2

* Map sheet 83 L/5 was not classified due to the absence of AVI data, instead a color composite of the map sheet was prepared.

2.2 Data Acquisition

Satellite data was obtained by AEP, Resource Data Division (RDD), through RADARSAT Canada. Ancillary data needed to register the imagery and to complete the image classification, image interpretation, and accuracy assessments were obtained through RDD.



MAP INFORMATION

SOURCE: Natural subregions provided in digital format by Alberta Environmental Protection, Resource Data Division

MAP PROJECTION: Transverse Mercator (10 Degree TM)

DATUM: NAD 27

SPHEROID: Clarke 1866

Natural Subregions

- | | |
|----------------------|----------------------|
| Alpine | Central Mixedwood |
| Sub-Alpine | Dry Mixedwood |
| Montane | Wetland Mixedwood |
| Upper Foothills | Sub-Arctic |
| Lower Foothills | Peace River Lowlands |
| Athabasca Plain | Boreal Highlands |
| Kazan Upland | Dry Mixedgrass |
| Foothills Parkland | Foothills Fescue |
| Peace River Parkland | Northern Fescue |
| Central Parkland | Mixedgrass |

LEGEND

Additional Features

- | | |
|--|----------------------------------|
| | Priority Site |
| | Follow-up Site |
| | Landsat Path and Scene Reference |



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Data obtained through RDD is summarized below.

1. *Digital Access/Land Use Data:* Roads and hydrography layers in the Access/Land Use database were used to register and in some cases orthorectify the Landsat imagery, as well as to create GIS maps.
2. *Elevation Data:* Digital elevation data was used to help register Landsat TM imagery and to refine ground cover classes during image interpretation.
3. *AVI Data:* AVI data was used for image stratification, image classification and accuracy assessments.
4. *Ancillary Data:* Black and white aerial photographs were interpreted for the Northeast Boreal, Parkland and Prairie Regions and used to for image classification and accuracy assessments.

2.3. Development of a Ground Cover Classification Scheme and Corresponding FBP Fuel Types for Alberta

2.3.1 Development of a Ground Cover Classification Scheme for Alberta

The Alberta EOP3 Ground Cover Classification Scheme (Table 2) was developed in consideration of AEP's request for 1:50 000 scale mapping to meet regional needs and to provide linkages with other Alberta mapping initiatives. The latter was particularly important to ensure EOP3 products would nest hierarchically with other province-wide initiatives, notably 1:100 000 Reconnaissance Vegetation Inventory (RVI) mapping, 1:20 000 AVI mapping, and 1:20 000 ecological mapping currently underway for most of Alberta's Southeast Slopes Region.

The classification scheme developed by Anderson et al. 1976, and the more recent scheme developed by Russell (1986) for Alberta Fish and Wildlife Division were used to help shape the Alberta EOP3 ground cover scheme. Work by Russell represented a sound reconnaissance-level classification. The national vegetation scheme developed by the National Vegetation Working Group of the Canadian Committee for Ecological Land Classification (Strong et al. 1990) also was used. All three schemes are hierarchical and have four to five principal levels in the hierarchy

Accordingly five principal categories were identified in the EOP3 scheme including:

- 1) anthropogenic
- 2) uplands
- 3) wetlands and water
- 4) barren lands
- 5) unclassified

Table 2.
Alberta EOP3 Ground Cover Classification Scheme, Codes¹ and Corresponding Fuel Types²
March 20, 1998

A. ANTHROPOGENIC

- | | |
|------------------------|--|
| 11. (URB) ¹ | Urban (cities, towns- mostly residential and downtown core areas) [NF] ² |
| 12. (COM) | Commercial and/or industrial (industrial parks, heavy oil sand development, refineries, wellsites, hydro generating facilities) [NF] |
| 13. (MRD) | Major road, highway, and/or railway [NF] |
| 14. (PIP) | Pipeline and/or power line right-of-way (corridors) [NF] |
| 15. (SUR) | Surface mine (coal), gravel pit, and /or spoil pile [NF] |
| 16. (FAR) | Farmstead and/or ranch (including shelter belts) [UK] |

2. Agricultural

- | | |
|-----------|---|
| 21. (ACR) | Cropland [NF] |
| 22. (AIR) | Irrigated land [NF] |
| 23. (ACL) | Agricultural clearing (recently cleared land, often with windrows) [UK] |

3. Clearcuts

31. (CGR) Graminoid (grass and sedge) dominated clearcut [O-1]
32. (CTS) Tree and shrub dominated clearcut [UK]
33. (CTR) Tree (replanted - immature trees, < 20 years) dominated clearcut [O-1]

4. Burns

41. (BG) Graminoid (grass and sedge) dominated burn [O-1]
42. (BTS) Tree and shrub dominated burn [UK]
43. (BT) Tree dominated burn [UK]

B. UPLANDS

5. Forested Lands (>6% Tree Cover)

Coniferous Dominated Forest (> 80% coniferous cover based on percent occurrence)

Closed (> 40% crown closure)	Open (6-40% crown closure)

- | | |
|--|---|
| 51. (BSC) Closed black spruce [C-2] | 151. (BSO) Open black spruce [C-1] |
| 52. (PC) Closed pine [C-3] | 152. (PO) Open pine [C-3] |
| 53. (WSC) Closed white spruce [C-2] | 153. (WSO) Open white spruce [C-3] |
| 54. (CUC) Closed undifferentiated coniferous [C-2] | 154. (UCO) Open undifferentiated coniferous [C-1] |

Table 2.
Alberta EOP3 Ground Cover Classification Scheme and Codes¹ and Corresponding Fuel Types²
(Continued)

5. Forested Lands (> 6% Tree Cover)

Deciduous Dominated Forest (> 80% deciduous cover based on percent occurrence)

Closed (> 40% crown closure)

Open (6-40% crown closure)

55. (DC) Closed aspen, balsam poplar and/or birch [D-1]

155. (DO) Open aspen, balsam poplar and/or birch [D-1]

05. (RIP) Riparian poplar [D-1]

Mixedwood Dominated Forest (> 20-80% mixedwood cover based on percent occurrence)

Closed (> 40% crown closure)

Open (6-40% crown closure)

56. (MCC) Closed coniferous dominated mixedwood (60-80% coniferous cover) [M1/M2]

156. (MCO) Open coniferous dominated mixedwood (60-80% coniferous cover) [M1/M2]

57. (MDC) Closed deciduous dominated mixedwood (60-80% deciduous cover) [M1/M2]

157. (MDO) Open deciduous dominated mixedwood (60-80% deciduous cover) [M1/M2]

58. (MCDC) Closed coniferous and deciduous mixedwood (20-60%) [M1/M2]

158. (MCDO) Open coniferous and deciduous mixedwood (20-60%) [M1/M2]

6. Shrublands (> 25% shrub cover and < 6% tree cover)

Closed shrublands (Crowns of most shrubs are interlocked)

- | | |
|-----------|---|
| 61. (RSC) | Closed riparian shrub(sandbar willow) [D-1] |
| 62. (CSC) | Closed coulee shrub thicket [D-1] |
| 63. (USC) | Closed upland shrub [D-1] |

Open shrublands

- | | |
|------------|---|
| 161. (RSO) | Open riparian shrub [O-1] |
| 162. (CSO) | Open coulee shrub thicket (i.e. chokecherry/buffaloberry, rose, buckbrush, saskatoon) [O-1] |
| 163. (USO) | Open upland shrub [O-1] |
| 164. (SO) | Open sagebrush flat [O-1] |

Table 2.
Alberta EOP3 Ground Cover Classification Scheme and Codes¹ and Corresponding Fuel Types²
(Continued)

7. Grasslands (<25% shrub cover and <6% tree cover) and Upland Forbs (<6% graminoid)

Graminoids (grasses and sedges)

- | | |
|----------|---|
| 71. (GF) | Fescue grassland [O-1] |
| 72. (GM) | Mixed grassland [O-1] |
| 73. (GS) | Sandhill grassland [O-1] |
| 74. (GC) | Coulee grassland (grassland on steep coulee slopes) [O-1] |

Upland Forbs

- | | |
|-----------|--------------------------|
| 75. (UFM) | Upland forb meadow [O-1] |
|-----------|--------------------------|

C. WETLANDS AND WATER

8. Wetlands

- | | |
|-----------|--|
| 81. (WE) | Emergent wetland (cattails) [NF] |
| 82. (WG) | Graminoid wetland (sedges and grasses and forbs) [NF] |
| 83. (WS) | Shrubby wetland (willow and birch fens in the north; willow swamps on the prairie) [O-1] |
| 84. (WSB) | Sphagnum bog [NF] |
| 85. (WOL) | Lichen bog [O-1] |
| 86. (WBS) | Black spruce bog (sphagnum understory) [NF] |
| 87. (WBL) | Black spruce bog (lichen understory) [O-1] |

9. Water

- | | |
|-----------|--|
| 91. (WTR) | Lake, pond, reservoir, river and/or stream |
|-----------|--|

D. BARREN LANDS

10. Barren (<6% Vegetation Cover)

- | | |
|------------|---|
| 101. (BPI) | Permanent ice and/or snow [NF] |
| 102. (BR) | Rock, talus and/or avalanche chute [NF] |
| 103. (BS) | Exposed soil [NF] |
| 104. (BAF) | Alkali flat and/or mud flat [NF] |
| 105. (BUD) | Upland dune field [NF] |
| 106. (BAD) | Alluvial deposit [NF] |
| 107. (BB) | Beach [NF] |
| 108. (BBL) | Badland [NF] |
| 109. (BBZ) | Blowout zone [NF] |

Table 2.
Alberta EOP3 Ground Cover Classification Scheme and Codes¹ and Corresponding Fuel Types²
(Concluded)

E. UNCLASSIFIED (Due to cloud cover, haze or shadow)

111. (UC)	Cloud [UC]
112. (UH)	Haze [UC]
113. (US)	Shadow [UC]

2. Codes for Corresponding FBP Fuel Types

C-1 = Spruce Lichen Woodland; C-2 = Boreal Spruce; C-3 = Mature Jack or Lodgepole Pine;
D-1 = Leafless Aspen; M1/M2 = Boreal Mixedwood Leafless and Green; O-1 = Matted and Standing
Grass NF = Non-fuel; UC = Unclassified; UK = Non corresponding FBP fuel type;
WA = Hydrography

Each of the five principal categories consisted of a number of sub-categories (Table 2). Anthropogenic included: 1) urban and industrial; 2) agriculture; 3) clearcuts; and 4) burns. These sub-categories represented ground covers the result of human activity. Uplands sub-categories included 1) forested lands; 2) shrublands; and 3) grasslands. Wetlands and water were broken into wetlands encompassing those found in northern Alberta, and more southern parkland and prairie wetlands. Water included lakes, ponds, reservoirs, rivers and/or streams. Barren lands were areas devoid of cover, and unclassified areas were associated with cloud, haze and shadow.

Definitions developed by Russell were used to define forested lands (> 6% tree cover); shrublands (> 25% shrub cover and < 6% tree cover); grasslands (< 25% shrub cover and < 6% tree cover) and upland forbs (< 6% graminoid); and barren lands (< 6% vegetation cover).

The scheme was developed through an iterative process of meetings, phone calls and faxes with regional staff and the Resource Data Division. As each region was classified further revisions were made to reflect the range of provincial ground covers. We anticipate ongoing revision of the scheme as more areas of the province are classified and mapped. To date, 64 discernible ground covers have been identified.

A detailed description of the ground cover scheme is provided in Appendix 1.

2.3.2 Development of Corresponding FBP Fuel Types for Ground Covers

One of the study objectives was to develop corresponding fire behaviour prediction (FBP) fuel types for EOP3 ground covers. This was undertaken in consideration of the Alberta Forest Service, Forest Protection Division, and their work related to fire control.

Staff from the Forest Protection Division reviewed the EOP3 ground cover classification scheme and assigned FBP fuel types to ground covers. Table 3 describes the FBP fuel types and corresponding codes used by the Alberta Forest Service. Table 2 shows the correspondence between fuel codes and ground covers.

Four FBP codes, not shown on Table 3, were developed to accommodate EOP3 ground covers. They included NF for Non-fuel (e.g., irrigate land); UC for Unclassified (e.g., cloud, haze or shadow); UK for Non-corresponding FBP fuel types (e.g., tree-dominated burns) and WA for hydrography. Even though there are two grass fuel types (O-1a matted grass and O-1b standing grass), O-1 was used for all grass types.

Table 3.
Fire Behaviour Prediction (FBP) Fuel Types

Category /Code	Description
1. Coniferous	
C-1.	Spruce-Lichen Woodland
C-2.	Boreal Spruce
C-3.	Mature Jack or Lodgepole Pine
C-4.	Immature Jack or Lodgepole Pine
C-5.	Red and White Pine
C-6.	Conifer Plantation
C-7.	Ponderosa Pine/Douglas Fir
2. Deciduous	
D-1.	Leafless Aspen
3. Mixedwood	
M-1.	Boreal Mixedwood - Leafless
M-2.	Boreal Mixedwood - Green
M-3.	Dead Balsam Fir/Mixedwood - Leafless
M-3.	Dead Balsam Fir/Mixedwood - Green
4. Slash	
S-1.	Jack or Lodgepole Pine Slash
S-2.	Spruce/Balsam Slash
S-3.	Coastal Cedar/Hemlock/Douglas Fir Slash
5. Open	
O-1a.	Matted Grass
O-1b.	Standing Grass

2.4 Ground Cover Classification

Ground cover was classified using a four step process including image rectification, image stratification, image classification, and image interpretation. Image rectification aims to correct distorted or degraded imagery to create a more faithful representation of the original satellite scene and to tie image coordinates to real world coordinates (i.e., UTM or latitude and longitude coordinates).

Image stratification and image classification were undertaken using an ISODATA clustering technique. This is an iterative process used to progressively discriminate natural spectral differences and to aggregate spectral data into appropriate ground cover classes. During image interpretation, the classified image is visually examined and class conflicts manually interpreted and edited. This is accomplished using ancillary data.

2.4.1 Image Geometric Correction and Orthorectification

Raw images usually contain geometric distortions so significant they cannot be used as maps. The source of distortions range from variations in the altitude, attitude and velocity of the sensor platform relative to factors such as panoramic distortion, earth curvature, atmospheric refraction, and relief displacement (Lillesand and Kiefer 1994). The intent of a geometric correction is to compensate for the distortions introduced by these factors to ensure the corrected image has the geometric integrity of a map by linking image coordinates to real world coordinates.

Landsat images purchased for the Alberta EOP3 initiative were registered to a network of well-distributed ground control points (GCPs). GCPs are known ground locations which can be located on digital imagery. Ground control points were collected using hardcopy, or if available digital, 1:50 000 scale NTS topographic maps. Experience has shown that root mean square (RMS) errors less than 0.5 (< 15 metres) are routinely achieved using 1:50 000 scale maps.

A digital elevation model (DEM) also was used as an extra channel of topographic information to provide information on elevation. The use of elevation data is necessary in regions of high relief to help rectify imagery in consideration of shape and aerial distortions. The process is known as orthorectification. Furthermore, elevation data can be used to improve the classification of ground covers and classification accuracies. Digital elevation models were used for images of the Southeast Slopes and Northeast Boreal Regions.

2.4.2 Image Stratification

Image stratification is a logical process in which a Landsat TM image is initially stratified into broad groups or strata using ISODATA clustering and aggregation of TM bands. For example, in the Northwest Boreal Region, Quarter Scenes 46-19 NE, four strata were identified as follows: 1) forest; 2) burns; 3) wetlands; and 4) waterbodies. During the

stratification process obvious conflicts will occur, e.g., clearcuts and recent burns will likely be grouped as part of the wetland strata. At this stage, these conflicts are acceptable because the objective of the stratification process is to produce three or four spectrally similar classes, which can be further subdivided into desired ground covers, during image classification. The purpose of stratification is to simplify the classification process by grouping similar spectral classes into broad strata.

2.4.3 Image Classification

Following stratification of the Landsat TM image, the spectral classes assigned to each stratum are further subdivided. Classification is undertaken separately for each stratum. This is accomplished by graphically masking the strata not under consideration.

Classification of ground cover in each stratum is an iterative process using ISODATA clustering techniques and different TM band combinations. For example, Landsat TM Bands 3, 4, and 5 are best suited to discriminate spectral classes under the forest mask, whereas TM Bands 2, 3, and 4 are best suited under the wetlands mask. Infrared Bands 4, 5, and 7 are useful for bedrock and possibly shrub ground covers.

Using known cover types at a select number of ground truth sites, clusters are further aggregated into the various ground covers present. By visually comparing the satellite image composite with field reconnaissance data, areas that initially appear misclassified are further resolved through ISODATA clustering, using masks for individual classes.

During image classification, ancillary data such as aerial photographs are highly desirable. Aerial photographs are useful in identifying ground cover classes. If field reconnaissance data is available, it also can be used during classification as ground truth data. Digital elevation data is useful in refining ground cover classes which have the same spectral signatures, e.g., elevation data can be used to separate upland poplar from riparian poplar.

2.4.4 Image Interpretation

Manual editing of ground cover classes through visual interpretation is a slow and time consuming process. In an operational environment, the objective is to limit the amount of manual editing. Image stratification and classification using different masks help to minimize the amount of manual editing; however, some class conflicts cannot be avoided.

Listed below are some of the more common conflicts identified during the EOP3 initiative.

- recent clearcuts often conflicted with wetland classes
- burns conflicted with shrubby bogs
- bedrock sometimes conflicted with burns
- bedrock conflicted with areas of exposed sand
- agriculture conflicted with some deciduous forest classes.
- urban areas conflicted with almost everything, but are separable using GIS.
- upland dune fields and beaches conflicted

Conflicts were resolved through visual interpretation, manual editing, and the expertise of experienced analysts. A capable analyst is able to determine which ground cover classes should be separated and which should not. It is important that all ancillary data, i.e., any data providing truth about a ground cover at a given location is used to classify and edit Landsat imagery.

A manual of image analysis procedures is included as Appendix 2.

2.5 Accuracy Assessment

Accuracy assessments are necessary in the development and use of large-scale thematic maps. One of the most common means of expressing classification accuracy is the preparation of a classification error matrix, sometimes called a confusion matrix or contingency table.

Error matrices compare on a category-by-category basis (i.e., for each ground cover class) the relationship between known reference data (ground truth) and the corresponding results of an automated classification. As each reference point is located and assigned to a ground cover, it is checked against the classified image and an error matrix produced. In general, a minimum acceptable overall accuracy is 80%. The minimum acceptable accuracy for any one class must be greater than 65%.

The sampling strategy used to collect and analyze a reference data set needed must be cost-effective, yet still achieve satisfactory precision for the estimated accuracy parameters (Stehman 1996).

2.5.1 Selection of a Reference Data Set for Accuracy Assessment

Several methods can be used to generate a reference data set suitable for a statistically valid accuracy assessment. Selection of the method used is influenced by the data available to ground truth the image. Methods which have been used for the creation of a reference data set include selecting sample points in either a systematic or random way.

Systematic sampling can be accomplished by:

- 1) using air photo coverage and selecting the centre of each air photo as a point in the reference data set; or,
- 2) automatically generating a grid over the classified image and using the grid intersections as points for the reference data set.

Simple random sampling can be accomplished by:

- 1) automatically generating a random set of points throughout the classified image; or,
- 2) using a stratified, random sample of a geographic region or any type of stratum.

The minimum number of sample points required for each ground cover class is dependent on the size of the area being mapped, the number of polygons mapped for each class, and the availability of ground truth data.

One of the most successful methods for the selection of a reference data set is stratified random sampling. For example, if a 1:50 000 map sheet was being classified the minimum requirement would be 10 polygons for each ground cover class. If a class is represented by fewer than 10 polygons, then every polygon is selected for the reference data set. The minimum number of polygons selected for the reference data set can also be determined using a frequency distribution of the mapped classes. Classes with the largest number of polygons will have the greatest number of points in the reference data set.

Each point selected for the reference data set is checked for its accuracy. Ideally, reference points would be verified based on field data checks. In many cases this option is not achievable because of budget constraints and/or project timing. Many analysts rely on the interpretation of aerial photographs for accuracy assessments; however, this introduces error based on the quality of interpretation of the airphotos.

2.5.2 Analysis Procedures

An error matrix can be used to study various classification errors of *omission* (exclusion) and *commission* (inclusion). As each reference point is located and assigned to a ground cover, it is checked against the classified image and assigned to the error matrix.

Pixels in the reference data set which have been classified into the correct ground cover classes are located along the major diagonal of the error matrix (running from the upper left to the lower right). All non-diagonal elements of the matrix represent either errors of omission or commission. Omission errors are pixels that should have been classified as a given ground cover, but were omitted from the ground cover class in question. Commission errors are pixels improperly included in a ground cover class.

Other descriptive measures can be obtained from an error matrix. The *overall accuracy* is computed by dividing the total number of correctly classified pixels by the total number of pixels from the reference data set. Accuracies of individual ground cover classes can be calculated by dividing the total number of correctly classified pixels by the total number of pixels in a corresponding row or column.

When the total number of correctly classified pixels for a ground cover class is divided by the total number of pixels from a corresponding column this is termed the *producer's accuracy*. It represents how well reference pixels for a given ground cover were classified.

When the total number of correctly classified pixels for a ground cover class is divided by the total number of pixels from the corresponding row this is termed the *user's accuracy*. This figure is a measure of commission error and indicates the probability a pixel classified in a given ground cover is representative of that ground cover.

In general, a minimum acceptable overall accuracy is 80%. The minimum acceptable accuracy for any one class must be greater than 65%.

2.6 Development of Prototype Outputs

Geographic Information System (GIS) technology is frequently used to combine image data for a given geographic area with other geographically referenced data for the same area. Not only does GIS provide an ideal environment in which to manipulate remotely sensed data, it can analyze data drawn from a broad range of sources and variety of collection techniques, assembling them into coherent and accessible map products. Specific benefits include:

- ⇒ consistency in data storage and analysis;
- ⇒ ease in data retrieval and file updating;
- ⇒ flexible applications of large and complex data sets;
- ⇒ efficient completion of modelling exercises for “what if” scenarios; and
- ⇒ production of high quality graphic output.

2.6.1 Hardcopy Output

GIS was used to produce maps of ground cover and FBP fuel types for priority sites in each region. GIS software was used to overlay Alberta government 1:50 000 Access/Land Use data on the classified imagery to produce maps with suitable reference points. Maps were constructed to show the following:

- ⇒ anthropogenic, upland, wetland and barren ground cover classes;
- ⇒ FBP fuel and non-fuel types
- ⇒ paved and gravel roads
- ⇒ trail, truck trail or seismic lines
- ⇒ major hydrography appropriately labelled;
- ⇒ Forest Management Unit (FMU) boundaries (where applicable)
- ⇒ Alberta protected area boundaries; and
- ⇒ a comprehensive legend including;
 - map title
 - required logos
 - summary statistics of ground cover classes

- sources of imagery and map information
- map projection
- datum used
- an inset map of Alberta showing the location of the map area

A manual of GIS mapping procedures using ArcView is included as Appendix 3.

2.6.2 Digital Output

A number of digital files have been created for each priority site. They include:

- 1) EASI/PACE 'pix' files of the classified image;
- 2) ARC/INFO export files (e00 format) of the classified coverage, vector files used to map the Access/Land Use data, and DEM for the Southeast Slopes and Northeast Boreal Regions;
- 3) ArcView project 'apr' files of hardcopy maps; and
- 4) metadata for all regions.

The naming convention used for digital files is provided in Appendix 4. All digital data has been provided on CD-Rom to Alberta Environmental Protection, Resource Data Division, in Edmonton. A smaller data set has been provided to the Canada Centre for Remote Sensing in Ottawa.

Appendix 5 provides a sample metadata summary for the Prairie Region. Metadata is becoming increasingly important to the long-term success of projects characterized by large volumes of data. The term refers to the background information associated with a data set. Metadata ensures that other users can effectively access data products with a minimum of effort. GAIA's metadata structure is partly based on the U.S. Federal Geographic Data Committee's (USFGDC) standards.

2.7 Technology Transfer and Training

Three training workshops were held to provide AEP and other end-users opportunity to assess the work in progress and to provide feedback. Image analysis methodologies and GIS mapping procedures were demonstrated and operational procedures discussed and reviewed. Training consisted of a review of all steps in the operational methodology to ensure participants were able to convey information and procedures to others, as well as conduct analyses themselves.

User manuals were prepared by both Geomatics (Appendix 2) and GAIA (Appendix 3) describing operational methodologies and procedures. These should allow AEP to conduct similar operational programs in-house or through contracting out.

3.0 PROJECT EVALUATION

This section evaluates various critical components of the projects outlining results and where difficulties were experienced.

3.1 Data Acquisition

The project suffered from the timely provision of data ultimately necessitating a reduction in the number of project deliverables. As a consequence, there was insufficient money in the budget to classify and map all priority sites identified by the regions. Instead priority sites were limited to a single, 1:50 000 map sheet selected to address as many land covers as possible. These problems are discussed in more detail below.

3.1.1 Digital Access/Land Use Data

Digital access/land use data was received in ARC/INFO export format (e00 files), grouped according to NTS map sheets. There were limited problems with this data. Time, however, was required to import the associated coverages, separate the files into layers and add the appropriate descriptions to items within these coverages. As well, data taken from different digital files had to be imported, snapped together, and correctly georeferenced.

3.1.2 Elevation Data

DEM data was supplied in DMDF format as opposed to ARC/INFO grid (e00) format. This format is unreadable by most GIS software leading to a request by GAIA to RDD to provide the e00 conversion program RDD supports. Data was ultimately provided in ARC ungenerate files.

This format requires the interpolation of surfaces. Given the size of the areas covered by the files, this represented a significant rate limiting step in completing the work. The size of the ungenerate files (as many as 30,000 lines for a single 1:20,000 map sheet), and the intensity of computations required to generate a surface demanded as much as three days processing time for the equivalent of two quarter scenes of DEM data.

This process assumed all files were in a useable format. Problems were found in a number of files. Processing time did not include time spent clustering data. Additionally, due to the size of the areas involved, and the occurrence of areas which encompassed more than one UTM zone, data had to be subdivided into a number of grids and then merged. This further increased processing time.

A number of AMLs (Arc Macro Language programs) were developed to automate the process of extracting the data from CD-Rom's, joining individual map sheets, extracting layers, and generating individual TINs and DEMs. The process of developing efficient and

accurate methods to create the DEMs was highly time consuming; however, an efficient process was eventually developed.

3.1.3 AVI Data

AVI data was received in Arc/Info export format (e00) by township and range. This data was derived from a number of different versions of the AVI database and required further processing prior to joining map coverages. Different data versions resulted in differences among attributes and coverages, requiring additional processing time to create acceptable coverages.

AVI data for some areas does not presently exist. Furthermore, AVI data for the Northeast Slopes Region was not available until two weeks before close of the project. As a consequence, imagery for this region was not classified. Instead a Landsat color composite for the associated map sheet 83 I/7 was created and land/use access data added to the resulting GIS map.

3.1.4 Ancillary Data

At the outset of the project, it was anticipated ancillary data would include data other than the principal data sets listed above. Woodlot information and permanent sample plot data were acquired for some regions, but proved unusable. Unfortunately, permanent sample plot data was not adequately georeferenced and arrived late in the project resulting in insufficient time to use the data for purposes of image stratification and classification.

3.2 Alberta Ground Cover Classification Scheme

GAIA had proposed an Advisory Committee be established to develop the Alberta Ground Cover Classification Scheme. This committee was to include representatives from the federal and provincial governments, industry, universities, and end-users of the product. Unfortunately, this did not take place, although substantial effort was devoted to developing a suitable committee and trying to convene the group. GAIA believes the ground cover classification scheme could be improved and should be reviewed by the kind of committee initially proposed, prior to finalizing the scheme and future modifications based on additional work.

Appendix 1 provides a description of EOP3 ground covers. Readers are urged to examine this appendix for detailed ground cover descriptions. Substantial time was spent developing the agricultural, shrublands, grasslands, and wetlands classes. in conjunction with regional staff.

Agricultural classes were kept intentionally simple. They were interpreted based on ground cover rather than a measure of grazing intensity or biomass. Biomass is affected not only by grazing intensity, but also moisture. Both vary considerably during a growing season. Measures of biomass were considered beyond the scope of the project.

Interpretation of 1:40 000 and 1:30 000 aerial photographs for the Prairie and Parkland Regions, respectively, identified more shrubland and grassland classes than eventually incorporated as part of the EOP3 ground cover scheme. Resolution of imagery prevented representation of the detail obtained from the interpreted aerial photographs.

Wetland classes were developed in consideration of wetlands in both northern and southern Alberta, based on the spectral reflectance of the associated vegetation and visual patterns. Emergent wetlands were confined almost exclusively to the Prairie and Parkland regions, whereas graminoid and shrubby wetlands occurred in both northern and southern Alberta.

3.3 Ground Cover Classification Procedures and Accuracy Assessment

3.3.1 Northwest Boreal Region - Landsat TM Scene, Path 48, Row 19, NE Quadrant

The full quarter TM scene was stratified, using ISODATA clustering and aggregation into groups or strata including: 1) forest; 2) upland wetlands; 3) lowland wetlands; and 4) waterbodies. TM Bands 3, 4, and 5 were used for the initial image stratification. Masks were generated for each strata followed by detailed image classification.

ISODATA clustering proceeded under the forest mask using TM Bands 3, 4, and 5, and under the wetlands masks using TM Bands 2, 3, and 4. Using a select number of ground truth sites, clusters were aggregated into the various ground covers present. Conflicts within each class were resolved by further ISODATA clustering under masks of each class.

Conflicts within wetland classes were resolved using TM Bands 4 and 5, as well as Bands 5 and 7. TM Bands 3, 4, and 5 worked best for separating deciduous and coniferous classes. Wetland classes were refined during a second field trip to the area using additional wetland ground truth data.

An area of haze in the eastern part of the image caused some problems. This area was addressed separately by creating a mask for the haze-affected area and running ISODATA clustering under that mask.

Editing of the final classification was necessary to add clearcuts and to identify riparian poplar from closed deciduous forest. The shrubby wetland class also represents cutlines of significant width. The final classification was filtered to a minimum polygon size of 2 ha.

3.3.2 Northwest Boreal Region - Landsat TM Scene, Path 46, Row 19, NE Quadrant

The full quarter TM scene was stratified, using ISODATA clustering and aggregation, into four strata: 1) forest; 2) burns; 3) wetlands; and 4) waterbodies. TM Bands 3, 4, and 5 were used for the initial image stratification and masks created for each stratum followed by detailed image classification.

ISODATA clustering proceeded under the forest mask using TM Bands 3, 4, and 5, and under the wetland masks using TM Bands 2, 3, and 4. Using a select number of ground truth sites, clusters were aggregated into the ground cover classes present. Conflicts within each class were resolved by further ISODATA clustering under the masks for each class.

All wetland classes conflicted with burns. This was resolved by creating a mask of all wetland classes and running ISODATA clustering under the mask using TM Bands 4, 5, and 7. Burns were separated from wetland areas in the cluster aggregation process. Wetland classes were also extracted from closed coniferous and burn classes using TM Bands 2, 3, and 4.

The remaining conflict consisted of burn classes included as wetland classes. This conflict was resolved using Principal Components 1 and 2 (using all TM bands as input), and TM Band 4 as input to the ISODATA clustering under the wetland mask. Both recent and regenerating clearcuts required manual editing. The final classification was filtered to a minimum polygon size of 2 ha, the nominal minimum size of AVI polygons.

Tables 4 and 5 provide the error matrices for the Northwest Boreal Region, Quarter Scenes 48-19 and 46-19. For both quarter scenes all field survey points were used as the reference data set to conduct the accuracy assessment. Field points also were used as ground truth data to classify the image. Ideally, two field data sets are preferred; one for classifying the image and a second for conducting the accuracy assessment. The remoteness of the area, however, prevented the collection of two separate data sets.

The overall accuracy for Quarter Scene 48-19 was 85% and for Quarter Scene 46-19 91.2% (Tables 4 and 5). An examination of the error matrices revealed pine cannot be accurately discriminated from other ground cover classes, primarily because areas of pine were not large enough or sufficiently homogenous to be easily distinguished. Pine was frequently classed as closed, coniferous dominated mixedwood or closed white spruce. Black spruce could not be accurately discriminated from white spruce and confusion existed amongst the mixedwood classes, particularly for Scene 48-19.

Table 4. Northwest Boreal Region, Landsat TM Scene Path 48, Row 19, NE Quadrant, Error Confusion Matrix ¹.

Ground Cover Class Code ²		TRUTH																				
		SUR	CCR	CTS	BG	BTS	BSC	BSO	PC	WSC	DC	RIP	MCC	MDC	MCDC	WG	WS	WSB	WBS	URB	Row Total	User's Accuracy
C L A S S I F I C A T I O N	SUR	1																			1	100.0%
	CCR		5																		5	100.0%
	CTS			10							1			1						1	13	76.9%
	BG				-																NA	NA
	BTS					-															NA	NA
	BSC						1			5											6	17.0%
	BSO							2													2	100.0%
	PC								-				3								3	0.0%
	WSC									25			1								26	96.2%
	DC										36		1								37	97.3%
R E S U L T S	RIP										3										3	100.0%
	MCC								4			7	1	1							13	53.8%
	MDC								1	3		3	2								9	22.2%
	MCDC									3		3		-							6	0.0%
	WG														25	3					28	89.3%
	WS															41			1		42	97.6%
	WSB																1	-			1	0.0%
	WBS																1		61		62	98.4%
	URB																			1	1	100.0%
	Column Total	1	5	10	NA	NA	1	2	0	35	43	3	18	4	1	25	46	0	63	1	220	
Producer's Accuracy	100.0%	100.0%	100.0%	NA	NA	100.0%	100.0%	0.0%	71.4%	83.7%	100.0%	38.9%	50.0%	0.0%	100.0%	89.0%	0.0%	96.8%	100.0%		85.3% ³	

¹ Classification results filtered to a 2 ha minimum mapping size. Zero fields have been left blank for clarity.² SUR=surface mine, gravel pit, and/or spoil pile; CCR=graminoid dominated clearcut; CTS=tree and shrub dominated clearcut; BG=graminoid dominated bog; BTS=tree and shrub dominated bog; BSC=tree and shrub dominated bog; BSO=tree and shrub dominated bog; PC=closed aspen, balsam poplar, and/or birch; RIP=riparian poplar; MCC=closed coniferous dominated mixedwood; MDC=closed deciduous dominated mixedwood; MCDC=closed deciduous dominated mixedwood; WG=shrubby wetland; WS=shrubby wetland; WSB=shrubby wetland; WBS=black spruce bog (sphagnum understory); URB=urban (cities, towns)³ Overall Accuracy: (Diagonal Sum / Grand Total x 100) 220/258 x 100 = 85.3%.

Table 5. Northwest Boreal Region, Landsat TM Scene Path 46, Row 19, NE Quadrant, Error Confusion Matrix.¹

Ground Cover Class Code ²		TRUTH																
		CCR	CTS	BG	BSC	BSO	PC	WSC	DC	MCC	MDC	MCDC	WG	WS	WOL	WBL	Row Total	User's Accuracy
C L A S S I F I C A T I O N R E S U L T S	CCR	8															8	100.0%
	CTS		2														2	100.0%
	BG			14													14	100.0%
	BSC				1			1									2	50.0%
	BSO					10											10	100.0%
	PC						.	1				1					2	0.0%
	WSC				1			13									14	92.8%
	DC								17								17	100.0%
	MCC									4							4	100.0%
	MDC								4		1						5	20.0%
	MCDC									2		1					3	33.3%
	WG												17	1			18	94.4%
	WS					1								20			21	95.2%
	WOL														6		6	100.0%
	WBL															10	10	100.0%
Column Total		8	2	14	2	11	0	15	21	6	1	2	17	21	6	10	124	
Producer's Accuracy		100.0%	100.0%	100.0%	50.0%	91.0%	0.0%	86.7%	81.0%	66.7%	100.0%	50.0%	100.0%	95.2%	100.0%	100.0%		91.2% ³

¹ Classification results filtered to a 2 ha minimum mapping size. Zero fields have been left blank for clarity.² CCR = graminoid dominated clearcut; CTS = tree and shrub dominated clearcut; BG = graminoid dominated burn; BSC = closed black spruce; BSO = open black spruce; PC = closed pine; WSC = closed white spruce; DC = closed aspen, balsam poplar, and/or birch; MCC = closed coniferous dominated mixedwood; MDC = closed deciduous dominated mixedwood; MCDC = closed coniferous and deciduous mixed wood; WG = graminoid wetland; WS = shrubby wetland; WOL = lichen bog; WBL = black spruce bog (lichen understory).³ Overall Accuracy: (Diagonal Sum / Grand Total x 100) 124/136 x 100 = 91.2%.

3.3.3 Northeast Boreal Region - Landsat TM Scene, Path 42, Row 22, SW and SE Quadrants, NTS Map Sheet 83 I/7

NTS map sheet, 83 I/7, was established as the priority site for the orthorectified scene. Image stratification was accomplished by aggregating into three strata: 1) croplands; 2) forest; and 3) water. This was accomplished using TM Bands 4, 5, and 7 as input to the ISODATA clustering. Interpreted aerial photography was used as ground truth.

The cropland and water strata represented the associated ground cover classes well, such that only the forest stratum required further subdivision into various forest and wetland classes. ISODATA clustering under the forest mask using TM Bands 3, 4, and 5 resulted in extraction of additional cropland and water. The remaining ground covers were extracted using a modified forest mask and TM Bands 3, 4, and 7 as input. ISODATA clustering under a mask of each new class further refined the classification results. TM Bands 3, 4, and 7 worked well for separating wetlands from forest cover, whereas TM Bands 3, 4, and 5 worked best for separating forest ground covers.

There was significant conflict between deciduous ground cover and shrubby wetlands. This was resolved by creating a conflict mask and manually editing the mask to separate deciduous cover from shrubby wetlands. In some areas of the priority site, shrubby wetlands conflicted with a number of other classes. This conflict was resolved by creating a mask of the wetland class in areas of conflict and ISODATA clustering using TM Bands 3, 4, and 7.

Manual editing of agricultural ground covers was required to resolve shrubby wetlands classed as deciduous ground covers, and croplands classed as shrubby wetlands and deciduous cover. Editing also was required to address small areas of open black spruce bog classed as mixedwood, and areas of open deciduous classed as shrubby wetlands. Agricultural clearings, urban and industrial sites also were added manually. The shrubby wetland class also represented cutlines of significant width. This final classification was filtered to a minimum polygon size of 1 ha

Stratified random sampling was used to collect accuracy assessment points. The overall accuracy was 89.4% (Table 6). Both errors of omission and commission occurred among wetland, deciduous, and mixedwood classes. Shrubby wetlands tended to typically conflict with closed and open deciduous forest, deciduous dominated mixedwood, and sphagnum bogs.

Minor errors occurred between cropland and agricultural clearings, closed deciduous forest, and shrubby wetlands. A few areas classed as closed deciduous forest were misclassified as open deciduous, closed deciduous dominated mixedwood, and shrubby wetland.

Table 6. Northeast Boreal Region, Landsat TM Scene, Path 42, Row 22, SW and SE Quadrants, NTS Map Sheet 83 I/7, Error Confusion Matrix.¹

Ground Cover Class Code ²		TRUTH																						
		URB	COM	MRD	PIP	SUR	FAR	ACR	CTS	BC	CUC	DC	MDC	GS	WG	WS	WSB	WBS	WTR	BS	DO	Row Total	User's Accuracy	
C L A S S I F I C A T I O N R E S U L T S	URB	4																				4	100.0%	
	COM		10																			10	100.0%	
	MRD			1																		1	100.0%	
	PIP				3																	3	100.0%	
	SUR		1			8																9	88.9%	
	FAR						3															3	100.0%	
	ACR											2				1						90	95.6%	
	CTS									5												5	100.0%	
	BC										7											7	100.0%	
	CUC											18							1			1	20	90.0%
	DC												53	2		4						2	61	86.9%
	MDC													6		1			3				13	46.2%
	GS														1								1	100.0%
	WG															2							2	100%
WS									1	1		4				43					2	51	84.3%	
WSB								1								1	5					7	71.4%	
WBS																2		18				20	90.0%	
WTR																			12			12	100.0%	
BS																				4		4	100.0%	
DO												1	1								14	16	87.5%	
Column Total	4	11	1	3	8	3	88	6	7	21	60	9	1	2	52	5	23	12	4	19	303			
Producer's Accuracy	100.0%	90.9%	100.0%	100.0%	100.0%	100.0%	97.7%	83.3%	100.0%	85.7%	88.3%	66.7%	100.0%	100.0%	82.7%	100.0%	78.3%	100.0%	100.0%	73.7%				
																								89.4% ³

¹ Classification results filtered to 1 ha minimum mapping size. Zero fields have been left blank for clarity.² URB=urban (cities, towns); COM=commercial; MRD=major road and/or railway; PIP=pipeline and/or powerline right-of-way; SUR=surface mine, gravel pit, and/or spoil pile; FAR=farmstead and/or ranch; ACR=cropland; CTS=tree and shrub dominated clearcut; BC=graminoid dominated burn; CUC=closed undifferentiated coniferous; DC=closed aspen, balsam poplar, and/or birch; DO=open aspen, balsam poplar, and/or birch; MDC=closed deciduous dominated mixedwood; GS=sandhill grassland; WG=graminoid wetland; WS=shrubby wetland; WBS=shrubby wetland; WSB=graminoid wetland; WTR=lake, pond, reservoir, river, and/or stream; BS=exposed soil.³ Overall Accuracy: (Diagonal Sum / Grand Total x 100) 303/339 x 100 = 89.4%

3.3.4 Southeast Slopes Region - Landsat TM Scene, Path 42, Row 25, NW Quadrant, NTS Map Sheets 82 J/10 and 82 J/15

NTS map sheets, 82 J/10 and 82 J/15, were established as priority sites for the orthorectified scene. TM data were stratified using ISODATA clustering and aggregation, into two strata: 1) forest; and 2) non-forest. TM Bands 3, 4, and 5 were used to initially stratify the image. Masks were generated for each stratum followed by detailed image classification.

ISODATA clustering proceeded under the forest and non-forest masks using TM Bands 3, 4, and 5. Cluster aggregation was guided by digital AVI data viewed through ARC. Each class extracted from under the initial strata contained conflict. Most of the conflict was resolved using ISODATA clustering under a mask for each class and TM Bands 4, 5, and 7.

Manual editing of the classification was required to extract clearcuts, cropland, wetlands, and water. Without aerial photographs or permanent sample plot data, spruce could not be differentiated from pine and is included in the pine class. The final classification was filtered to a minimum polygon size of 2 ha.

Stratified random sampling was used to collect accuracy assessment points. AVI data were used as truth data. Overall accuracy was 83.8% (Table 7). Closed pine, one of the most dominant ground covers in the area had a user's accuracy of 80.5%. The majority of conflict occurred with closed undifferentiated conifer, open undifferentiated conifer, and deciduous and mixedwood classes.

Confusion was also common between mixedwood classes. Areas of closed coniferous dominated mixedwood were classed as closed pine and closed deciduous dominated mixedwood. Areas of closed deciduous dominated mixedwood were misclassified as closed pine, closed and open undifferentiated conifer, closed deciduous, closed conifer dominated mixed wood, and shrubby wetlands. These errors are to be expected based on spectral similarities and the absence of additional ground truth such as interpreted aerial photographs and permanent sample plot data.

3.3.5 Parkland Region - Landsat TM Scene, Path 41, Row 24, NW Quadrant, NTS Map Sheet 82 P/15

NTS map sheet 83 P/15 was established as the priority site for the geocorrected TM scene for the Parkland Region. Using ISODATA clustering with TM Bands 3, 4, and 5 the priority site was stratified into six strata including: 1) water; 2) croplands; 3) closed deciduous forest; 4) fescue grasslands; 5) badlands; and 6) clouds. Interpreted aerial photography was used as ground truth. Wetlands were extracted from the cropland, deciduous, and fescue strata using TM Bands 2, 3, and 4 for ISODATA clustering. Initially croplands were included in the hardwood strata, but were extracted using TM Bands 4, 5, and 7 as input.

Manual editing was required to identify closed white spruce and riparian poplar in river valleys. Cropland was edited in areas where it was misclassified as fescue grasslands. This classification was filtered with a 3 by 3 modal filter to preserve wetland details within grassland areas.

Stratified random sampling was used to collect accuracy assessment points. Aerial photographs were used as ground truth. The overall accuracy for the study site (93.7%) (Table 8) was high. The majority of error was due to spectral confusion between closed deciduous and shrubby wetland ground covers, and a commission error where closed deciduous was misclassified as closed white spruce. This occurred on steep river valley slopes in topographic shadow. Minor commission errors were present in the cropland class. These included a few areas of fescue grassland, shrubby wetlands, water, and badlands.

3.3.6 Prairie Region - Landsat TM Scene, Path 39, Row 26, NW Quadrant, NTS Map Sheet 72 E/2

NTS map sheet 72 E/2 was established as the priority site for the geocorrected TM scene selected for the Prairie Region. Two initial strata were created; 1) croplands; and 2) non-croplands. The cropland mask was produced through a process of manual editing and the non-cropland mask became the entire study site less the cropland mask. The non-cropland mask was further classified into four strata: 1) grasslands 2) badlands; 3) other vegetation; and 4) water. TM Bands 4, 5, and 7 were used as input for ISODATA clustering of these strata. Ground truth was provided as interpreted aerial photographs.

Shrublands were extracted from the grasslands mask using TM Bands 2, 4, and 7. Shrublands, grasslands and cropland were extracted from the badland mask using TM Bands 3, 4, and 5. Further refinements to the classification were accomplished by ISODATA clustering under masks for each class using TM Bands 3, 4, and 5 as input. Success was generally limited and manual editing was required to extract various shrubland classes, riparian poplar, shrubby wetlands, alkaline flats, beaches along the Milk River, and homesteads. The final classification was filtered to a minimum polygon size of 0.5 ha.

Stratified random sampling was used to collect accuracy assessment points. Aerial photographs were used as ground truth. Overall accuracy was 88.6% (Table 9). Open and closed shrub ground covers, plus coulee grasslands were problematic both as errors of omission and commission. Coulee grasslands had numerous errors of omission. Classes that were spectrally confused with coulee grasslands included open coulee shrub thickets, open sagebrush flats, open riparian shrubs, and mixed grasslands. Some of these errors could have been removed through manual editing; however, in the coulee environment it was difficult to precisely locate ground truth on the aerial photographs during editing. This problem results in an expensive, time consuming editing process.

Table 8. Parkland Region, Landsat TM Scene, Path 41, Row 24, NW Quadrant, NTS Map Sheet 82 P/15, Error Confusion Matrix.¹

Ground Cover Class Code ²		TRUTH																			
		RIP	URB	SUR	FAR	ACR	WSC	DC	GM	WG	WS	WTR	BAF	BBL	UC	US	RSC	SO	CSO	Row Total	User's Accuracy
C L A S S I F I C A T I O N	RIP	10																		10	100.0%
	URB		1																	1	100.0%
	SUR			1																1	100.0%
	FAR				10															10	100.0%
	ACR					58														58	100.0%
	WSC						8	2												10	80.0%
	DC							20	1											21	95.2%
	GM					4		1	51											56	91.1%
	WG									1										1	100.0%
	WS					1		3	1		16						1			21	76.2%
	WTR					1						12								14	85.7%
	BAF												10							10	100%
	BBL					1								13						14	92.9%
	UC														10					10	100.0%
R E S U L T S	US														10				10	100.0%	
	RSC																1			1	100.0%
	SO																	3		3	100.0%
	CSO																	1	1	1	100.0%
	Column Total	10	1	1	10	65	8	26	53	1	16	12	10	13	10	11	1	3	1	236	
Producer's Accuracy		100.0%	100.0%	100.0%	100.0%	89.2%	100.0%	76.9%	96.2%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	90.9%	100.0%	100.0%	100.0%		93.7% ³

¹ Classification results filtered to 0.5 ha minimum mapping size. Zero fields have been left blank for clarity.

² URB=urban (cities, towns); SUR=surface mine, gravel pit, and/or spoil pile; FAR=farmstead and/or ranch; ACR=cropland; WSC=closed white spruce; DC=closed aspen, balsam poplar, and/or birch; RIP=riparian poplar; CSO=open coulee thicket; SO=open sagebrush flat; GM=mixed grassland; WG=graminoid wetland; WS=shrubby wetland; WTR=lake, pond, reservoir, river, and/or stream; BAF=alkali flat and/or mud flat; BBL=badland; UC=cloud; US=shadow; RSC=closed riparian shrub.

³ Overall Accuracy: (Diagonal Sum / Grand Total x 100) 236/252 x 100 = 93.7%

Shrub related errors of commission were present to a lesser degree. For example, open shrub thickets were misclassified as badlands; open riparian shrub was confused with closed riparian shrub and exposed soil; and open coulee shrub may be misclassified as mixed grassland.

3.4 Technology Transfer and Training

Two image analysis training workshop and one GIS mapping workshop were held in Edmonton. These courses were well attended, particularly the GIS training course; however knowledge among the participants varied substantially making teaching difficult at times. None-the-less courses met the objectives established for the project, and most participants should be able to convey information and procedures to others, as well as conduct analyses themselves.

4.0 COST ESTIMATES FOR PROVIDING A SIMILAR PRODUCT

Cost estimates to prepare a similar product for six, 1:50 000 NTS map sheets, in conjunction with RDD, are based on six critical tasks and associated subtasks. These are itemized below.

Task 1.	Data Acquisition and Import	
1.1	Data Dictionary Development	
1.2	Acquisition and Handling of Satellite Imagery	
1.3	Acquisition and Handling of Land Use/Access Mapping, AVI Data and Elevation Data	
1.4	Acquisition and Handling of Aerial Photography	
	Estimated Professional Fees	\$17 500.00
Task 2.	Landsat TM Rectification	
2.1	Georectification	
2.2	Orthorectification	
	Estimated Professional Fees	\$2 500.00
Task 3.	Data Acquisition and Import	
3.1	Identification of Training Sites	
3.2	Image Stratification and Classification	
3.3	Image Interpretation	
3.4	Accuracy Assessment	
	Estimated Professional Fees	\$20 000.00
Task 4	GIS Project File Creation	
4.1	Digital Coverage Preparation	
4.2	Map Generation	
	Estimated Professional Fees	\$10 000.00
Task 5	Metadata Creation	
	Estimated Professional Fees	\$2 500.00
Task 6	Report Production	
	Estimated Professional Fees	\$7 500.00

Total estimated costs, exclusive of disbursement costs such as the purchase of satellite imagery, aerial photographs, map printing, and associated field costs are estimated at \$50 000.00 for six 1:50 000 NTS map sheets. These costs are exclusive of the GST.

5.0 FOLLOW-UP MARKETING ACTIVITIES

The ground cover classification scheme was developed in consideration of end-users and linkages with other schemes. Linkages with other mapping endeavours are essential if the products associated with the current project are to be widely used.

Linkages have already been made with the Eastern Slopes Grizzly Bear Project (ESGBP) which is currently mapping the Bow River watershed. This project is interested in obtaining digital copies of the classified satellite imagery and resulting GIS map products for NTS map sheets 82 J/10 and 82 J/15. In return they are willing to provide detailed sample plot data for improving overall map accuracies. The ESGBP is partly funded by the Alberta government.

Rigel Oil and Gas Ltd. has established an agreement with the Resource Data Division to classify and map the area south of NTS map sheets 82 J/10 and 82 J/15 to Waterton National Park. Please see Figure 1 and the area identified as the follow-up site. Rigel is willing to cover the costs of classifying the imagery available through RDD in exchange for not having to purchase the imagery. Both parties benefit. RDD will have classified satellite imagery and maps prepared using the EOP3 Ground Cover Classification Scheme. Rigel will have the same for their area of interest without the costs of having had to purchase the satellite imagery.

Other petroleum companies have expressed interest in developing Rigel-like arrangements with RDD, notably for images already purchased and for which ground cover mapping has not been undertaken. A number of FMA holders and smaller sawmills also have expressed interest.

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Appendix 1. Description of Alberta EOP3 Ground Cover Classes

Overview

Provided below is a description of EOP3 ground covers for those classes which may not be self-evident. Five principal categories were identified including: 1) anthropogenic; 2) uplands; 3) wetlands and water; 4) barren lands; and 5) unclassified. Each major category was characterized by a number of sub-categories and corresponding ground cover classes.

A. ANTHROPOGENIC

The anthropogenic category represents ground covers the result of human activity.

1. Urban and Industrial

Ground covers associated with Urban and Industrial activity should be self-evident, with the possible exception of Class 16. This class includes farm buildings and shelter belts associated with farm buildings.

- | | |
|-----------|---|
| 11. (URB) | Urban (cities, towns- mostly residential and downtown core areas) |
| 12. (COM) | Commercial and/or industrial (industrial parks, heavy oil sand development, refineries, wellsites, hydro generating facilities) |
| 13. (MRD) | Major road, highway, and/or railway |
| 14. (PIP) | Pipeline and/or power line right-of-way (corridors) |
| 15. (SUR) | Surface mine (coal), gravel pit, and /or spoil pile |
| 16. (FAR) | Farmstead and/or ranch (including shelter belts) |

2. Agricultural

Agricultural classes were kept intentionally simple. They were interpreted based on ground cover rather than a measure of grazing intensity or biomass. Biomass is affected by both grazing intensity and moisture, and can vary considerably during a growing season. Measures of biomass were considered beyond the scope of the project. Cropland includes cereal and forage crops and seeded pasture. Agricultural clearings are large areas of land recently cleared and often characterized by windrows. This ground cover class was visually identified.

- | | |
|-----------|--|
| 21. (ACR) | Cropland |
| 22. (AIR) | Irrigated land |
| 23. (ACL) | Agricultural clearing (recently cleared land, often with windrows) |

3. Clearcuts

Clearcuts were identified based on discernible vegetation. Generally younger cuts were characterized by graminoids, intermediate-aged cuts by a mixture of trees and shrubs, and mature clearcuts by even-aged trees. AVI data was essentially in distinguishing clearcuts.

- | | |
|-----------|--|
| 31. (CGR) | Graminoid (grass and sedge) dominated clearcut |
| 32. (CTS) | Tree and shrub dominated clearcut |
| 33. (CTR) | Tree (replanted - immature trees, < 20 years) dominated clearcut |

4. Burns

Burns were identified based on discernible vegetation. Generally younger burns were characterized by graminoids, intermediate-aged burns by a mixture of trees and shrubs, and mature burns by even-aged trees. Ground truth was essential for distinguishing clearcuts from burns. This data was supplied by the Alberta Forest Service.

- | | |
|-----------|--|
| 41. (BG) | Graminoid (grass and sedge) dominated burn |
| 42. (BTS) | Tree and shrub dominated burn |
| 43. (BT) | Tree dominated burn |

B. UPLANDS

Uplands included three sub-categories, forested lands, shrublands and grasslands. The provincial Reconnaissance Vegetation Inventory (RVI) was used to distinguish among these sub-categories based on percent tree, shrub and grass cover, as well as to determine crown closure. Coniferous dominated and deciduous dominated ground covers should be self-evident. Mixedwood dominated ground covers are either coniferous dominated (Classes 56 and 156) or deciduous dominated (Classes 57 and 157). Classes 58 and 158 are mixedwood stands where neither coniferous nor deciduous cover is dominate, but rather softwoods and hardwoods occur in relatively the same percentages, covering 20% to 60% of an area.

5. Forested Lands (> 6% Tree Cover)

Coniferous Dominated Forest (> 80% coniferous cover based on percent occurrence)	
Closed (> 40% crown closure)	Open (6-40% crown closure)

- | | |
|---|---|
| 51. (BSC) Closed black spruce | 151. (BSO) Open black spruce |
| 52. (PC) Closed pine | 152. (PO) Open pine |
| 53. (WSC) Closed white spruce | 153. (WSO) Open white spruce |
| 54. (CUC) Closed undifferentiated
coniferous | 154. (UCO) Open undifferentiated coniferous |

5. Forested Lands (> 6% Tree Cover)

Deciduous Dominated Forest (> 80% deciduous cover based on occurrence)	
Closed (> 40% crown closure)	Open (6-40% crown closure)

- | | |
|--|---|
| 55. (DC) Closed aspen, balsam poplar and/or
birch | 155. (DO) Open aspen, balsam poplar and/or
birch |
| 05. (RIP) Riparian poplar | |

Mixedwood Dominated Forest (> 20-80% mixedwood cover based on occurrence)	
Closed (> 40% crown closure)	Open (6-40% crown closure)

- | | |
|--|---|
| 56. (MCC) Closed coniferous dominated
mixedwood (60-80% coniferous cover) | 156. (MCO) Open coniferous dominated
mixedwood (60-80% coniferous cover) |
| 57. (MDC) Closed deciduous dominated
mixedwood (60-80% deciduous cover) | 157. (MDO) Open deciduous dominated
mixedwood (60-80% deciduous cover) |
| 58. (MCDC) Closed coniferous and
deciduous mixedwood (20-60%) | 158. (MCDO) Open coniferous and deciduous
mixedwood (20-60%) |

6. Shrublands (>25% shrub cover and <6% tree cover)

Interpreted aerial photographs were used to identify a broad range of shrubland covers including tall and low shrubs. The latter two categories were not used due to difficulty in distinguishing them on satellite imagery. Other shrub covers were grouped for the same reason. Coulee shrub thickets could consist of chokecherry, saskatoon, wolf willow, buffaloberry, buckbrush, and rose. Upland shrubs frequently included the same species. Elevation data was used to separate most shrublands.

Closed shrublands (Crowns of most shrubs are interlocked)

- | | |
|-----------|--|
| 61. (RSC) | Closed riparian shrub (Sandbar willow) |
| 62. (CSC) | Closed coulee shrub thicket |
| 63. (USC) | Closed upland shrub |

Open shrublands (Crowns of most shrubs are not touching)

- | | |
|------------|---|
| 161. (RSO) | Open riparian shrub |
| 162. (CSO) | Open coulee shrub thicket (i.e. chokecherry/buffaloberry, rose, buckbrush, saskatoon) |
| 163. (USO) | Open upland shrub |
| 164. (SO) | Open sagebrush flat |

7. Grasslands (<25% shrub cover and <6% tree cover) and Upland Forbs (<6% graminoid)

Grasslands were a broad category. It is anticipated the ground covers identified will be refined with subsequent work. Fescue and sandhill grasslands were distinguishable due to adequate ground truth. Coulee grasslands were distinguished using elevation data. Mixed grasslands encompassed a significant range of spectral values. Upland forbs were included as a ground cover to capture upper elevation forb meadows common to the Southeast and Northeast slopes regions

Graminoids (grasses and sedges)

- | | |
|----------|---|
| 71. (GF) | Fescue grassland |
| 72. (GM) | Mixed grassland |
| 73. (GS) | Sandhill grassland |
| 74. (GC) | Coulee grassland (grassland on steep coulee slopes) |

Upland Forbs

- | | |
|-----------|--------------------|
| 75. (UFM) | Upland forb meadow |
|-----------|--------------------|

C. WETLANDS AND WATER

8. Wetlands

Wetlands ground covers were developed in consideration of those found in northern Alberta, as well as those characteristic of the Parkland and Prairie regions. Emergent wetlands are common to southern and central Alberta. Graminoid wetlands in the south are semi-permanent wetlands characterized by a sedge and a wet meadow fringe of grasses and forbs. Shrubby wetlands in the north are frequently fens, whereas in the Parkland and Prairie regions they are usually wetland basins ringed with willow and often poplar. The latter are visually distinctive.

- | | |
|-----------|--|
| 81. (WE) | Emergent wetland (cattails) |
| 82. (WG) | Graminoid wetland (sedges and grasses and forbs) |
| 83. (WS) | Shrubby wetland (willow and birch fens in the north; willow swamps on the prairie) |
| 84. (WSB) | Sphagnum bog (includes floating bogs) |
| 85. (WOL) | Lichen bog |
| 86. (WBS) | Black spruce bog (sphagnum understory) |
| 87. (WBL) | Black spruce bog (lichen understory) |

9. Water

This category included both standing and flowing water.

- 91. (WTR) Lake, pond, reservoir, river and/or stream

D. BARREN LANDS

Barren lands were areas devoid of cover.

10. Barren (<6% Vegetation Cover)

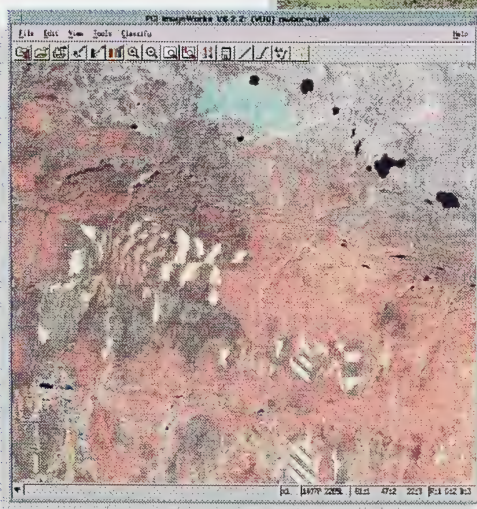
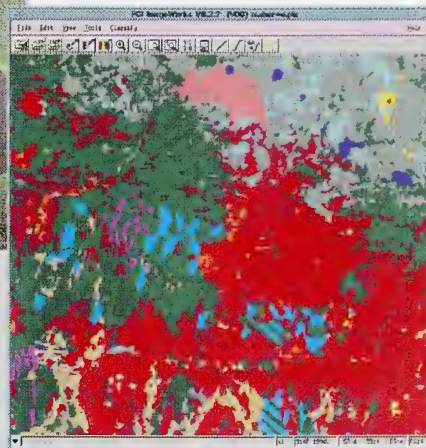
- 101. (BPI) Permanent ice and/or snow
- 102. (BR) Rock, talus and/or avalanche chute
- 103. (BS) Exposed soil
- 104. (BAF) Alkali flat and/or mud flat
- 105. (BUD) Upland dune field
- 106. (BAD) Alluvial deposit
- 107. (BB) Beach
- 108. (BBL) Badland
- 109. (BBZ) Blowout zone

E. UNCLASSIFIED (Due to cloud cover, haze or shadow)

- 111. (UC) Cloud
- 112. (UH) Haze
- 113. (US) Shadow

Introduction To: Satellite Image Analysis Procedures Using PCI EASI/PACE

Part of the Earth Observation Pilot Projects
Program (EOP3) Canada Centre for Remote Sensing



Prepared for:
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Resource Data Division
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GEOMATICS PRESENTS AN:

Introduction To:
Satellite Image Analysis
Procedures Using PCI
EASI/PACE

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IMAGE ANALYSIS TECHNOLOGY TRANSFER COURSE

1.0 IMAGE ORTHORECTIFICATION

Landsat TM images are orthorectified using ground control points which tie or link image coordinates to map coordinates and a digital elevation model (DEM). Ground control point coordinates are collected using hard copy (or vectors if available) 1:50 000 scale NTS topographic maps. Experience has shown that RMS errors less than 0.5 (< 15 metres) are routinely achieved using the 1:50 000 scale maps. RMS error reports can be generated.

Imagery is commonly resampled to 25 metres using cubic convolution resampling.

- Read image from CD-ROM.
- Read digital elevation model (DEM) from CD-ROM.
- Read roads and hydrology vector data into the PCIDSK file.
- Collect ground control points (GCPs).
- Orthorectify image.

1.1 Exercise 1: Image Orthorectification, SE Slopes

The raw Landsat TM data are on your hard drive. If you were to read it from a CD-ROM provided by Radarsat International you would run the following task:

CDLAND - Read CDROM, TM LGSOWG Format

Status the task. Type:

```
s cdlandc
```

This responds with a listing of parameters and definitions. You enter the parameter values as follows:

```
cddir="path  
file="filename  
cdic=1,5,7  
report="term
```

Status the task to check parameter settings:

```
s cdland
```

Run the task:

```
r cdland
```

VECREAD - Import ARC format .lin vector data:

```
s vecread
```

```
filv="filename.lin"
```

```
vecform="arc"
```

```
vecunit="utm 11 e000"
```

```
file="
```

```
dbsn="
```

```
dbsd="
```

```
s vecread
```

```
r vecread
```

The digital elevation model is on your hard drive. If you had to import it from ARC format you would run the following task:

FIMPORT - Import foreign file (ARC DEM):

```
s fimport
```

```
fil="demfile.grd"
```

```
filo="output filename"
```

```
s fimport
```

```
r fimport
```

GCPWORKS - Collect ground control points:

r gcpworks

- Full Processing
- Vectors
- Accept
- Select Uncorrected Image
- Select Vectors
- Define Georeferenced Area
- Collect GCPs
- Save GCPs

GCPELEV - Flag GCPs with elevations from DEM:

s gcpelev

file=

filedem="demfilename"

dbg=

dbec=

backelev=0

s gcpelev

r gcpelev

SMODEL - Satellite model calculation:

s smodel

file=

dbg=

orbit=

model=

modinput="y"

ellips="e000"

errunit="metre

report="term

s smodel

r smodel

SORTHO - Image orthorectification:

s sortho

fili=file

filo="output filename

filedem="

dbic=

dboc=dbic

dbec=

backelev=0

model=

pxszout=25,25

resample="cubic

s sortho

r sortho

To create the Southeast Slopes sub-area for classification:

- In *imageworks* load the new file created by sortho, full res, 1 channel, no graphic planes.

file browse

utility subset

- Type in name of destination file.
- Change *database corners* to *geocoded corners*.
- Determine UTM database corner coordinates using the NTS mapsheets for the Southeast Slopes (82 J/10 and 82 J/15).

subetable layers.....select all

- Click on *subset* button.

2.0 CLASSIFICATION

The most efficient means of ground cover classification is a three step process: image stratification; classification; and interpretation. Image stratification and classification utilize unsupervised ISODATA clustering techniques for classifying the ground cover. Interpretation is the final step where the classified image is visually examined and class conflicts and classes that are defined according to landscape rather than cover (i.e., riparian poplar) are manually interpreted and edited.

2.1 Image Stratification

The first step in the classification process is stratification. A Landsat TM scene is classified into a number of general classes. In the boreal forest, water, forest, wetlands and burns were used. NOTE: Strata may vary depending on the study area location within the province of Alberta. Stratification is undertaken using unsupervised ISODATA clustering techniques.

This method is best described as a reverse supervised classification. It works by the analyst first requesting a large number of clusters, for example 100. Natural spectral differences are automatically discriminated by this process. The analyst then uses the ground truth information to group or aggregate the clusters into the general classes selected earlier.

During the stratification process obvious conflicts will be observed, i.e., clearcuts and recent burns will likely be classed with the wetland strata; agricultural fields may go either to forest or wetlands depending upon the time of year and moisture content. At this stage these conflicts are acceptable because the objective of the stratification is to have three or four spectrally similar classes which can be further subdivided into the desired ground cover classes. The purpose of stratification is to make the classification process simpler in that only certain land cover classes will occur within each stratum.

2.2 Image Classification

Once a Landsat TM scene has been stratified, the analyst then classifies areas within each stratum separately using ISODATA clustering techniques with different band combinations.

Ground cover classification under each strata is an iterative process using ISODATA clustering techniques. Different input bands can be used to obtain the desired classes for example, Landsat TM Bands 3, 4, 5 are best

suited to discriminate forest classes whereas bands 2, 3, 4 are better for classifying wetlands. Infrared bands (4, 5, 7) are used for bedrock and possibly shrub. Areas that conflict can be grouped and separated with a different set of bands however, the experienced analyst knows which classes cannot be separated and that will require manual editing through interpretation. This experience is obtained by practice.

2.3 Image Interpretation

Manual classification editing through visual interpretation is a slow and time consuming process and adds time and expense to the classification process. In an operational environment the objective is to prepare the ground cover classification to a point where only a minimum amount of time is spent on editing. Classification using strata (described above) and 6 of 7 TM bands (Band 6, the thermal band is excluded) is a technique that minimizes the amount of manual editing.

A few class conflicts identified from experience are listed below. This list is by no means complete; other conflicts are resolved through visual interpretation with manual editing.

1. Recent cutovers conflict with wetland classes.
2. Burns conflict with shrubby bogs.
3. Bedrock may conflict with burns.
4. Bedrock conflicts with areas of exposed sand.
5. Agriculture conflicts with deciduous forest classes.
6. Urban conflicts with almost everything.
7. Landscape classes:
 - riparian poplar;
 - upland dune fields;
 - beaches; and,
 - upland low shrubs.

During the classification and editing process, ground truth in the form of complete air photo coverage is desirable. Air photo interpretation aids in the identification of many classes. If field survey information is available it can be used during the classification process as ground truth.

It is important that all ancillary information, *i.e.* any data that indicates the truth regarding the land cover at a particular point on the ground, is used to classify and interpret/edit the Landsat TM image.

2.4 Exercise 2: Image Classification, Southeast Slopes Region

- Stratify the image by creating general classes such as Vegetated, Barren, and No Data.
- Create an initial classification of the image under masks of the general strata.
- Run classification sessions under a mask of each class generated so far, with the goal of refining these initial classes and accounting for all the classes present in the scene.
- Make note of unresolved conflicts that will require post-classification editing.

Ground truth is an AVI coverage which can be viewed in ARC, the AVI Codes are listed in Appendix 3.

PCIMOD - PCIDSK file modification

Use PCIMOD to add two working channels to the database. One channel is used to receive the results from the first ISODATA clustering. The second channel will receive results from subsequent ISODATA clusterings. Type:

```
s pcimod
file="
pciop="add
pcival=2
s pcimod
r pcimod
```

VECREAD - Import AVI polygons:

```
s vecread
filv="filename.pnt
vecform="arc
vecunit="utm 11 e000
file="
dbsn="AVI
dbsd="AVI polygons
s vecread
```

r vecread

ISOCLUS - Isodata clustering:

s isoclus

file=

dbic=

dboc= *first working channel (7)*

mask=

numclus=

maxclus=

seedfile= (default)

minclus= 16

maxiter= 20

movethrs= 0.01

siggen= "no"

samprm= 5

stdv= 3

lump= 1

maxpair= 5

updprm= "no"

report= "term"

s isoclus

r isoclus

Open an ARC EDIT session and an IMAGEWORKS session simultaneously to perform image classification.

ARC SESSION:

arc

display 9999

ae

ec v_bragck
de arc
draw
ef poly
select
list

In imageworks aggregate the clusters into desired strata (image stratification).

IMAGEWORKS SESSION:

r iworks

set imageworks configuration (4 channels, 8 bitmaps)
file... load image...

enhance image
view...fullres window

display channel 4 as PC
edit...PCT...random
classify...aggregate

set input to 4

create aggregate list and edit colours

aggregate clusters

save session...lut
close

LUT - Apply look-up table to ISOCLUS output:

s lut
file = "
dbic =

dblut =
dboc=dbic
mask =
s lut
r lut

THR - Create bitmap masks for each strata

s thr
file = "
dbic =
dbob =
tval =
comp = "off
dbsn = "
dbsd = "
s thr
r thr

REPEAT THE ISODATA CLUSTERING UNDER EACH MASK TO EXTRACT ALL CLASSES PRESENT, THEN REPEAT THE PROCEDURE UNDER MASKS OF INDIVIDUAL CLASSES AS REQUIRED, AS OFTEN AS NECESSARY TO REFINE THE GROUND COVER CLASSIFICATION.

NOTE: Before running ISODATA clustering again, please note that the database output channel (dboc) must be the second working channel, and must be cleared before each subsequent run of isoclus. Never put isoclus results to a channel that has previous data on it. ISOCLUS does not preclear that channel.

When you run lut on the results in the second working channel, have the output channel equal to the first working channel. This way you will build the classification in that first channel.

3.0 CLASSIFICATION EDITING / INTERPRETATION

- Edit unresolved conflicts using imageworks, DEM edit and MODEL.

3.1 Exercise 3: Image Classification, Prairie Region

- Stratify the image by creating general classes such as, Grasslands, Cropland, other vegetation, and Water. The Cropland mask must be created using Edit Graphic in imageworks.
- Create an initial classification of the image under masks of the general strata.
- Run classification sessions under a mask of each class generated so far, with the goal of refining these initial classes and accounting for all the classes present in the scene.
- Make note of unresolved conflicts that will require post-classification editing.
- Ground truth is provided in the form of interpreted aerial photographs.

PCIMOD - PCIDSK file modification

Use PCIMOD to add two working channels to the database. One channel is used to receive the results from the first ISODATA clustering. The second channel will receive results from subsequent ISODATA clusterings.

```
s pcimod  
file="  
pciop="add  
pcival=2  
s pcimod  
r pcimod
```

Familiarize yourself with the area to be classified by examining and interpreting air photographs and any additional ancillary information.

ISOCLUS - Isodata clustering:

```
s isoclus  
file="  
dbic=
```

dboc = *first working channel (7)*
mask =
numclus =
maxclus =
seedfile = (default)
minclus = 16
maxiter = 20
movethrs = 0.01
sigen = "no"
samprm = 5
stdv = 3
lump = 1
maxpair = 5
updprm = "no"
report = "term"
s isoclus
r isoclus

In imageworks aggregate the clusters into desired strata (image stratification).

IMAGEWORKS SESSION:

r iworks

set imageworks configuration (4 channels, 8 bitmaps)

file... load image...

enhance image

view...fullres window

display channel 4 as PC

edit...PCT...random

classify...aggregate

set input to 4

create aggregate list and edit colours

aggregate clusters

save session...lut

close

LUT - Apply look-up table:

s lut

file = "

dbic =

dblut =

dboc = dbic

mask =

s lut

r lut

THR - Mask creation:

s thr

file = "

dbic =

dbob =

tval =

comp = "off

dbsn = "

dbsd = "

s thr

r thr

REPEAT THE ISODATA CLUSTERING UNDER EACH MASK TO EXTRACT ALL CLASSES PRESENT, THEN REPEAT THE PROCEDURE UNDER MASKS OF INDIVIDUAL CLASSES AS REQUIRED, AS OFTEN AS NECESSARY TO REFINE THE GROUND COVER CLASSIFICATION.

NOTE: Before running ISODATA clustering again, please note that the database output channel (dboc) must be the second working channel, and must be cleared before each subsequent run of isoclus. Never put isoclus results to a channel that has previous data on it. ISOCLUS does not preclear that channel.

When you run lut on the results in the second working channel, have the output channel equal to the first working channel. This way you will build the classification in that first channel.

4.0 CLASSIFICATION EDITING / INTERPRETATION

- Edit unresolved conflicts using imageworks, DEM edit and MODEL.

4.1 Exercise 4: Image Classification, Northwest Boreal Region

- Stratify the image by creating general classes such as forest, wetlands, water, and burns.
- Create an initial classification of the image under masks of the general strata.
- Run classification sessions under a mask of each class generated so far, with the goal of refining these initial classes and accounting for all the classes present in the scene.
- Make note of unresolved conflicts that will require post-classification editing.
- Ground truth is provided in a vector segment and on aerial photography.

PCIMOD - PCIDSK file modification

Use PCIMOD to add two working channels to the database. One channel is used to receive the results from the first ISODATA clustering. The second channel will receive results from subsequent ISODATA clusterings.

```
s pcimod  
file=" "  
pciop="add
```

pcival=2

s pcimod

r pcimod

Familiarize yourself with the area to be classified by examining all field survey information and relating it to the aerial photographs and any additional ancillary data.

ISOCLUS - Isodata clustering:

s isoclus

file=

dbic=

dboc = *first working channel (7)*

mask=

numclus=

maxclus=

seedfile=(default)

minclus=16

maxiter=20

movethrs=0.01

siggen="no

samprm=5

stdv=3

lump=1

maxpair=5

updprm="no

report="term

In imageworks aggregate the clusters into desired strata (image stratification).

IMAGEWORKS SESSION:

r iworks

set imageworks configuration (4 channels, 8 bitmaps)

file... load image...

enhance image

view...fullres window

display channel 4 as PC

edit...PCT...random

classify aggregate

set input to 4

create aggregate list and edit colours

aggregate clusters

save session...lut

close

LUT - Apply look-up table:

s lut

file=

dbic=

dblut=

dboc=dbic

mask=

s lut

r lut

THR - Mask creation:

file = "
dbic =
dbob =
tval =
comp = "off
dbsn = "
dbsd = "

REPEAT THE ISODATA CLUSTERING UNDER EACH MASK TO EXTRACT ALL CLASSES PRESENT, THEN REPEAT THE PROCEDURE UNDER MASKS OF INDIVIDUAL CLASSES AS REQUIRED, AS OFTEN AS NECESSARY TO REFINE THE GROUND COVER CLASSIFICATION.

NOTE: Before running ISODATA clustering again, please note that the database output channel (dboc) must be the second working channel, and must be cleared before each subsequent run of isoclus. Never put isoclus results to a channel that has previous data on it. ISOCLUS does not preclear that channel.

When you run lut on the results in the second working channel, have the output channel equal to the first working channel. This way you will build the classification in that first channel.

5.0 CLASSIFICATION EDITING / INTERPRETATION

- Edit unresolved conflicts using imageworks, DEM edit and MODEL.

6.0 POST-CLASSIFICATION PROCESSING

6.1 Classification Filtering

- Filter the final classification result to a minimum mapping size of 2 hectares.
- A new channel of classified, filtered data will be generated.

PCIMOD - PCIDSK file modification

Use PCIMOD to add one working channel to the database. This channel is used to receive the results from the filter, use the isoclus working channel for the cleancls working channel.

```
s pcimod
file=""
pciop="add
pcival=1
s pcimod
r pcimod
```

CLEANCLS - filter to minimum mapping size:

```
s cleancls
file=""
dbic=classification ch #
dboc=8
dbwc=9
backval=255
sthresh=32 (2 hectares)
iter=20
keepvalu=class list of up to 16 classes
s cleancls
r cleancls
```

6.2 Vector Creation and Export to ARC

- Create a vector segment from the final classification channel.
- Generate .lin and .pnt files from the vector segment.
- Generate an ARC coverage using the >lin and .pnt files.

RTV - Raster to vector conversion:

```
s rtv
file=""
```

```
dbic=classification ch #
dbsn="vectors
dbsd="classification vectors and points
polyinfo="both
border="on
continuit=
s rtv
r rtv
```

VECWRT - Export vector segment to .lin and .pnt files:

```
s vecwrit
file="
dbvs=vector segment #
filv=fileneame (no extension)
vecform="arc
arcid="attr
acadattr=
report="term
s vecwrit
r vecwrit
```

In ARC:

```
generate <cover>
input <cover.lin>
lines
input <cover.pnt>
points
q
build <cover> poly
```

7.0 ACCURACY ASSESSMENT

7.1 Introduction

Accuracy assessments are expensive but necessary in the development and eventual use of large-scale thematic maps. The sampling strategy used to collect and analyse the reference data set required for an accuracy assessment must be cost-effective, yet still achieve satisfactory precision for the estimated accuracy parameters (Stehman 1996).

Stehman, S.V. 1996. Cost Effective, Practical Sampling Strategies for Accuracy Assessment of Large-Area Thematic Maps. Proceedings, Spatial Accuracy Assessment in Natural Resources and Environmental Sciences: Second International Symposium, pp. 485-492.

Selection of the Reference Data Set To Be Used For Accuracy Assessment

Several methods can be used to generate a reference data set suitable for a statistically valid accuracy assessment. Selection of the method used is influenced by the data used to ground truth the image. Methods which have been used for the creation of a reference data set include selecting points in either a systematic or random way.

Systematic sampling can be accomplished by:

- 1) using air photo coverage and selecting the centre of each air photo as a point in the reference data set; or,
- 2) by automatically generating a grid over the classified image and using the grid intersections as points for the reference data set.

Simple random sampling can be accomplished by:

- 1) automatically generating a random set of points throughout the classified image; or,
- 2) by using a stratified, random sample of a geographic region or any type of stratum.

The advantage of the latter is that sample size can be controlled in each region. In addition, stratum-specific estimates have a smaller variance compared to estimates obtained using simple random sampling or another equal probability design such as systematic or cluster sampling (Stehman 1996).

7.2 Analysis

The objective of an accuracy assessment is to develop a sample error matrix and to compute estimates of various accuracy parameters; typically the overall proportion of pixels correctly classified, a user's accuracy, and a producer's accuracy.

Each pixel (or polygon) selected from the reference data set can be labelled as correctly or incorrectly classified. A population error matrix is constructed from these results in which the rows of the error matrix represent the results of the image classification, or user's accuracy, and the columns represent the reference classifications, or producer's accuracy.

The minimum number of sample points required for each ground cover class is dependent on the size of the area being mapped, the number of polygons mapped for each class, and the availability of field or other data.

One of the most successful methods for the selection of a reference data set is stratified random sampling. For example, if one were mapping a 1:50 000 map sheet, the minimum requirement would be 10 polygons for each ground class. If a class is represented by fewer than 10 polygons then every polygon is selected for the reference data set. The minimum number of polygons selected for the reference data set can also be determined by using a frequency distribution of the mapped classes. Classes with the largest number of polygons will have the greatest number of reference points in the reference data set.

Each point selected for the reference data set is checked for its accuracy. Ideally one would select the reference points and check each point in the field. In many cases this option is not achievable because of budget constraints and/or project timing (cannot check ground cover if snow covered). Many analysts rely on the interpretation of air photos for accuracy assessments; however, this introduces error based on the quality of interpretation of the air photos.

As each point is located and assigned to a ground cover, it is checked against the classified image and an error matrix produced. In general, a minimum acceptable overall accuracy is 80%. The minimum acceptable accuracy for any one class must be greater than 65%.

Example error matrices for the Northwest Boreal Region, Landsat TM Scene Path 48, Row 19, NE Quadrant and Landsat TM Scene Path 46, Row 19, NE Quadrant are provided in Appendix 3. All field survey points were used as the

reference data set for the accuracy assessment. These field points were also used as ground truth data to classify the image. Ideally, one would have two field data sets, one for classifying the image and another for conducting the accuracy assessment; however, in remote areas, the collection of two separate data sets is often not cost effective.

7.3 Exercise 1 : Accuracy Assessment - Systematic Sampling, Grid Generation

In this method, a regular grid overlain on the reference image determines sample points. Generate a grid as a vector segment in your image file using gratic. The gratic parameters are as follows:

```
s gratic
file="
bx1="
by1="
bx2="
by2="
ginc="
mapres=25
vecunit="utm 11 e000
dbgeo=1
vtype="line
dbsn="grid
dbsd="grid
s gratic
r gratic
```

In imageworks load vector segment just created. Select every 5th grid intersection and determine the Landsat class of the pixel at the intersection. Then *edit vector; new point* to add a point at the grid intersections inspected thus far. Check every point against the ground truth and image classification to build the error matrix and calculate accuracy.

7.4 Exercise 2: Accuracy Assessment - Stratified Random Sampling

In this method the user randomly picks the polygons to be used for the reference data set and accuracy assessment.

First, in *Imageworks* display one class at a time using *pseudocolour tables*. The background should be black with no image. Ideally you should not be affected by location.

Using *vector edit* window, select *new points* from within the desired number of polygons to be used for accuracy assessment. For example, if one is displaying class 82 and 30 polygons are required for accuracy assessment, the analyst selects 30 points from the displayed polygons. Make sure that the polygons selected are from across the entire image.

When complete, save the points selected, highlight the next class and select the required number of points (polygons). All points from all classes will be saved in the same auxiliary segment as in the database.

When the reference data set is complete, display the image and points selected. Check every point against the ground truth and image classification to build the error matrix and calculate accuracy.

7.5 Exercise 3: Accuracy Assessment - Automated Random Sampling (using *Imageworks*)

In *Imageworks* select *classify, accuracy assessment* and follow the dialogue boxes. This is an automated method of selecting a sample set and producing error matrices.

Appendix 1: Classification Scheme

Alberta EOP3 Land Cover Classification Scheme
March 20, 1998

A. ANTHROPOGENIC

1. Urban and Industrial

- 11. (URB) Urban (cities, towns- mostly residential and downtown core areas)
- 12. (COM) Commercial and/or industrial (industrial parks, heavy oil sand development, refineries, wellsites, hydro generating facilities)
- 13. (MRD) Major road, highway, and/or railway
- 14. (PIP) Pipeline and/or power line right-of-way (corridors)
- 15. (SUR) Surface mine (coal), gravel pit, and /or spoil pile
- 16. (FAR) Farmstead and/or ranch (including shelter belts)

2. Agricultural

- 21. (ACR) Cropland
- 22. (AIR) Irrigated land
- 23. (ACL) Agricultural clearing (recently cleared land, often with windrows)

3. Clearcuts

- 31. (CGR) Graminoid (grass and sedge) dominated clearcut
- 32. (CTS) Tree and shrub dominated clearcut
- 33. (CTR) Tree (replanted - immature trees, <20 years) dominated clearcut

4. Burns

- 41. (BG) Graminoid (grass and sedge) dominated burn
- 42. (BTS) Tree and shrub dominated burn
- 43. (BT) Tree dominated burn

B. UPLANDS

5. Forested Lands (>6% Tree Cover)

Coniferous Dominated Forest (>80% coniferous cover based on occurrence)

Closed (>40% crown closure)

Open (6-40% crown closure)

51. (BSC) Closed black spruce

151. (BSO) Open black spruce

52. (PC) Closed pine

152. (PO) Open pine

53. (WSC) Closed white Spruce

153. (WSO) Open white spruce

54. (CUC) Closed undifferentiated
coniferous

154. (UCO) Open undifferentiated coniferous

Deciduous Dominated Forest (>80% deciduous cover based on occurrence)

Closed (>40% crown closure)

Open (6-40% crown closure)

55. (DC) Closed aspen, balsam poplar and/or
birch

155. (DO) Open aspen, balsam poplar and/or
birch

05. (RIP) Riparian poplar

Mixed Wood Dominated Forest (>20-80% mixed wood cover based on occurrence)

Closed (>40% crown closure)

Open (6-40% crown closure)

56. (MCC) Closed coniferous dominated
mixedwood (60-80% coniferous cover)

156. (MCO) Open coniferous dominated
mixedwood (60-80% coniferous cover)

57. (MDC) Closed deciduous dominated
mixedwood (60-80% deciduous cover)

157. (MDO) Open deciduous dominated
mixedwood (60-80% deciduous cover)

58. (MCDC) Closed coniferous and
deciduous mixedwood (20-60%)

158. (MCDO) Open coniferous and deciduous
mixedwood (20-60%)

6. Shrublands (>25% shrub cover and <6% tree cover)

Closed shrublands (streams and coolies)

61. (RSC) Closed riparian shrub

62. (CSC) Closed coulee shrub thicket

63. (USC) Closed upland shrub

Open shrublands

161. (RSO) Open riparian shrub

162. (CSO) Open coulee shrub thicket (i.e. chokecherry/buffaloberry, rose,
buckbrush, saskatoon)

163. (USO) Open upland shrub

164. (SO) Open sagebrush flat

7. Grasslands (<25% shrub cover and <6% tree cover) and Upland Forbs (<6% graminoid)

Graminoids (grasses and sedges)

- 71. (GF) Fescue grassland
- 72. (GM) Mixed grassland
- 73. (GS) Sandhill grassland
- 74. (GC) Coulee grassland (grassland on steep coulee slopes)

Upland Forbs

- 75. (UFM) Upland forb meadow

C. WETLANDS AND WATER

8. Wetlands

- 81. (WE) Emergent wetland (cattails)
- 82. (WG) Graminoid wetland (sedges and grasses and forbs)
- 83. (WS) Shrubby wetland (willow and birch fens in the north; willow swamps on the prairie)
- 84. (WSB) Sphagnum bog
- 85. (WOL) Lichen bog
- 86. (WBS) Black spruce bog (Sphagnum understory)
- 87. (WBL) Black spruce bog (lichen understory)

9. Water

- 91. (WTR) Lake, pond, reservoir, river and/or stream

D. BARREN LANDS

10. Barren (<6% Vegetation Cover)

- 101. (BPI) Permanent ice and/or snow
- 102. (BR) Rock, talus and/or avalanche chute
- 103. (BS) Exposed soil
- 104. (BAF) Alkali flat and/or mud flat
- 105. (BUD) Upland dune field
- 106. (BAD) Alluvial deposit
- 107. (BB) Beach
- 108. (BBL) Badland
- 109. (BBZ) Blowout zone

E. UNCLASSIFIED (Due to cloud cover, haze or shadow)

- 111. (UC) Cloud
- 112. (UH) Haze
- 113. (US) Shadow

Appendix 2: AVI Codes

Summary of AVI Codes

Attribute / Code	Description
------------------	-------------

Moisture regime

MOIST_REG	Description
d	dry - rapidly drained
m	mesic - well drained
w	wet - poorly drained
a	aquatic

Density

DENSITY	Description (refers to crown closure)
A	6 - 30 %
B	31 - 50 %
C	51 - 70 %
D	71 - 100 %

Height of stand

HEIGHT	Description
0-99	Height to nearest meter

Tree Species

SPECIES	Description
<i>(In order of abundance)</i>	<i>Note: Number indicates percentage by area (eg. Sw 6 --> 60%White spruce)</i>
Sw	White spruce
Sw (Se)	Engelmann spruce
Sb	Black spruce
P (Pl)	Lodgepole pine
P (Pj)	Jack pine
P (Pa)	White-bark pine
P (Pf)	Limber pine
Fb	Balsam fir
Fb (Fa)	Alpine fir
Fd	Douglas fir
Lt (La)	Alpine larch
Lt (La)	Tamarack
Lt (Lw)	Western Larch
Aw	Trembling aspen
Pb	Balsam poplar
Bw	White birch
A	Undifferentiated <i>Populus</i> spp.

Summary of AVI Codes

Attribute / Code	Description
------------------	-------------

Age of Stand

ORIGIN	Description
1990	1990-99
1980	1980-89
1970	1970-79
1960	1960-69
ETC.	

Non-forested vegetated land

Non_Forest_Land	Description
1 to 6 preceding	height descriptors for shrubs (metres)
SC	closed shrub (interlocking crowns)
SO	open shrubs
HG	herbaceous grassland
HF	herbaceous forbes
BR	Bryophytes, mosses
1 to 10 following	% shrub cover over area

Natural non- vegetated landcover

Natur_nonveg	Description
NWI	water
NWL	permanent ice/snow
NWR	flooded areas (periodically)
NMB	recent burn
NMC	cutbank
NMR	rock barren
NMS	sand

Antropogenic non- vegetated landcovers

Anthropo_nonveg	Description
ASC	cities, towns, hamlets
ASR	ribbon development, not agriculture
AIH	right of ways, roads, reservoirs, railways
AIE	peat extraction
AIG	gravel pits
AIF	farmsteads
AIM	surface mines
All	plant sites, lagoons

Summary of AVI Codes

Attribute / Code	Description
------------------	-------------

Anthropogenic landcovers

Anthropo_veg	Description
CA	agriculture - annual crops
CP	agriculture - perennial crops
CPR	agriculture - rough pasture (unimproved, less than 10% woody area)
CIP	industrial - seeded areas including pipelines, transmission lines and airstrips
CIW	industrial - geophysical seeded areas including well sites

Stand Modifiers

STND_MOD1 OR 2	Description
CC	clear cut / partial cut
BU	burn / partial burn
WF	windfall
CL	clearing
DI	disease
IK	insect kill
UK	unknown kill
WE	weather (red belt)
DT	discoloured / dead tops
BT	broken tops
SN	snags
ST	scattered timber
SI	site improved (fertilizer, drainage)
SC	seedbed preparation (scarified, weed suppressed)
PL	planted or seeded
TH	thinned
GR	developed for grazing
IR	irrigated

Extent of modifier

Note: *Single digit following snag or treatment indicates extent of treatment (eg. CC5, SN2), followed by year, if known. (eg. CC51960)*

EXTENT	Description
1	Light (1-25 % of area affected)
2	Moderate (26-50%)
3	Heavy (51-75%)
4	Severe (76-94%)
5	Entire

Appendix 3: Error Confusion Matrices

Table 1. Northwest Boreal Region, Landsat TM Scene Path 48, Row 19, NE Quadrant, Error Confusion Matrix ¹.

Ground Cover Class Code ²		TRUTH																				
		SUR	CCR	CTS	BG	BTS	BSC	BSO	PC	WSC	DC	RIP	MCC	MDC	MCDC	WG	WS	WSB	WBS	URB	Row Total	User's Accuracy
C L A S S I F I C A T I O N	SUR	1																			1	100.0%
	CCR		5																		5	100.0%
	CTS			10							1			1						1	13	76.9%
	BG																				NA	NA
	BTS																				NA	NA
	BSC																				6	17.0%
	BSO						1			5											2	100.0%
	PC																				3	0.0%
	WSC									25			1								26	96.2%
	DC										36		1								37	97.3%
	RIP											3									3	100.0%
	MCC									4			7	1	1						13	53.8%
	MDC									1	3		3	2							9	22.2%
	MCDC										3		3		-						6	0.0%
	WG															25	3				28	89.3%
	WS																41		1		42	97.6%
WSB																1	-			1	0.0%	
WBS																1		61		62	98.4%	
URB																			1	1	100.0%	
Column Total	1	5	10	NA	NA	1	2	0	35	43	3	18	4	1	25	46	0	63	1	220		
Producer's Accuracy	100.0%	100.0%	100.0%	NA	NA	100.0%	100.0%	0.0%	71.4%	83.7%	100.0%	38.9%	50.0%	0.0%	100.0%	89.0%	0.0%	96.8%	100.0%		85.3% ³	

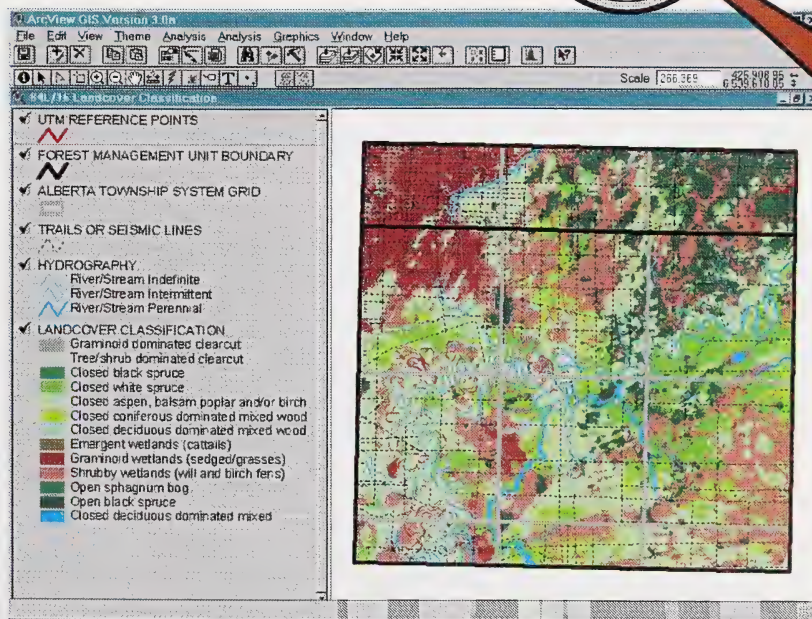
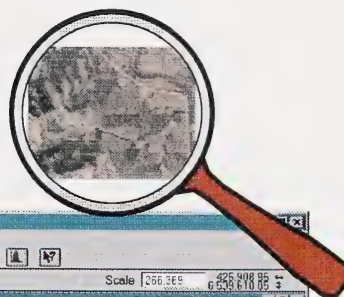
¹ Classification results filtered to a 2 ha minimum mapping size. Zero fields have been left blank for clarity.

² SUR=surface mine, gravel pit, and/or spoil pile; CCR=grainoid dominated clearcut; CTS=tree and shrub dominated clearcut; BTS=tree and shrub dominated burn; BSC=closed black spruce; BSO=open black spruce; PC=closed pine; WSC=closed white spruce; DC=closed aspen, balsam poplar, and/or birch; RIP=riparian poplar; MCC=closed coniferous dominated mixedwood; MDC=closed deciduous dominated mixedwood; MCDC=closed coniferous and deciduous mixedwood; WG=grainoid wetland; WS=shrubby wetland; WSB=sphagnum bog; WBS=black-spruce bog (sphagnum understory); URB=urban (cities, towns)

³ Overall Accuracy: (Diagonal Sum / Grand Total x 100) 220/256 x 100 = 85.3%.

Introduction To: GIS Mapping Using ArcView 3.0a

Part of the Earth Observation Pilot Projects
Program (EOP3) Canada Centre for Remote Sensing



Prepared for:
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Resource Data Division
March 31, 1998



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GAIA PRESENTS AN:

Introduction To:
GIS Mapping
Using ArcView 3.0a

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Introductory GIS/Mapping Concepts

Establishing a sound understanding of basic Geographic Information System (GIS) and mapping concepts is essential prior to exploring how ArcView® can be used to create and manage spatial data effectively and efficiently. Chapter 1 outlines some fundamental building blocks of GIS and mapping in the following sections:

- GIS Overview;
- Data and Feature Types;
- Data Structures; and,
- Spatial Analyses.

This Chapter is not meant to replace an introductory GIS course; instead, it is designed as a refresher for those who already have a basic understanding of spatial data in a digital environment.

ICON KEY

 Valuable information

 Tips and Tricks

 Tech Talk

GIS Overview

Defining GIS

GIS technology was developed in Canada approximately 30 years ago and continues to evolve. Definitions of GIS are moving away from informal definitions that focus on software (e.g., spatial database management system or spatial mapping system) to definitions that include “components” and “functions”. A widely accepted definition used for this manual is as follows:

A GIS is a system of hardware, software, and data that facilitates the development, enhancement, modelling, and display of multivariate (e.g., multi-layered) spatially referenced data. (Hastings, 1992)

What sets a GIS apart from other computer mapping software, is that a GIS permits spatial operations on the data (ESRI, 1995). For more detailed definitions of GIS and its functionality, visit the following web site:

<http://www.ngdc.noaa.gov/seg/globsys/gis/gisdefs.html>

Functionality

GIS is a tool—powered by users, software, and data—that can increase effectiveness and efficiency of spatial data management, analyses, and presentation. A GIS environment is ideal for storing, updating, querying, and displaying spatial data in a digital environment. Complex spatial processes can be modelled in a GIS environment. GIS, when established correctly, can permit multi-user and enterprise-wide solutions for managing and analysing spatial information. As a predictive tool, GIS can act as a Decision Support System (DSS) and aid in developing hypothetical scenarios based on existing baseline data.

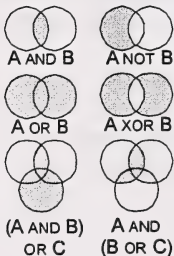
Data and Feature Types

Simply put, data is information and information fuels most planning and management decisions. A GIS is ideal for managing large amounts of information. Generally, data in a GIS can be classified into one of three types:

1. **Nominal data** used to name features (e.g., numbers on a hockey jersey);
2. **Ordinal data** used to represent position, or order, in a series (e.g., 1st place); and,
3. **Cardinal data** used to represent constant units of measurement, permits the use of arithmetic operations (such as adding, subtracting, multiplying, and dividing), and is truly quantitative (e.g., 50.23 cm). Interval and ratio data are examples of cardinal data.



Boolean algebra uses operators such as **AND**, **OR**, **XOR**, **NOT** to establish whether a specific set of conditions are **TRUE** or **FALSE**.



Data can vary within these groupings as well: nominal data can be numeric (integer or real), string, or Boolean; ordinal data can be numeric (integer or real) or string; and cardinal data can only be numeric (integer or real). For statistical operations, cardinal data is preferred to ordinal data, which is preferred to nominal data.

Although there are exceptions, items within a GIS are stored in a spatial database as one of four feature types depending on the nature of the data:

Point feature

A point feature is a discrete location, usually depicted by a symbol or label. Points represent locations that have no area, such as mountain peaks. Also, a point can be used to define a feature whose boundary or shape is too small to be shown as

a line or area, as a function of scale. A point consists of one set of X,Y coordinates (i.e., a Cartesian Coordinate).

Line feature

A line feature is a set of ordered Cartesian Coordinates that, when connected, represent the linear shape of a map feature too narrow to display as an area. These Cartesian Coordinates are stored in the GIS as a series of connected *nodes* and *vertices*. A line also can be a feature that has no width, such as a contour line. Lines are often referred to as *arcs*.

Area feature

An area feature is a homogeneous region enclosed by a line who's starting node is also its ending node. Example area features include provinces, vegetation types, or water bodies. These features also are referred to as *polygons*.

Raster feature

In a raster environment, each feature (i.e., point, line, or area) location is represented as a square cell or a matrix of cells. This matrix of cells, organised into rows and columns, is called a GRID within ESRI products.

It has been said that:
raster is faster...
but vector is "corrector".



Some of the above feature types can be divided further into subgroups, beyond the scope of this manual.

Data Structures

Geographical data for all feature types can be stored and manipulated in a GIS environment. The GIS methods used to organise geographic data for feature types are important to understand. In order to perform spatial analyses, data must be stored in a functional and consistent manner.

There are two types of information stored for each feature type: *spatial* and *descriptive*.

Spatial Information

Describes the X, Y, (Z) location and consequent shape of geographic features, and their spatial relationship to each other.

Descriptive Information

Includes descriptive information or characteristics of geographic features. This type of information is also known as *attribute data*.

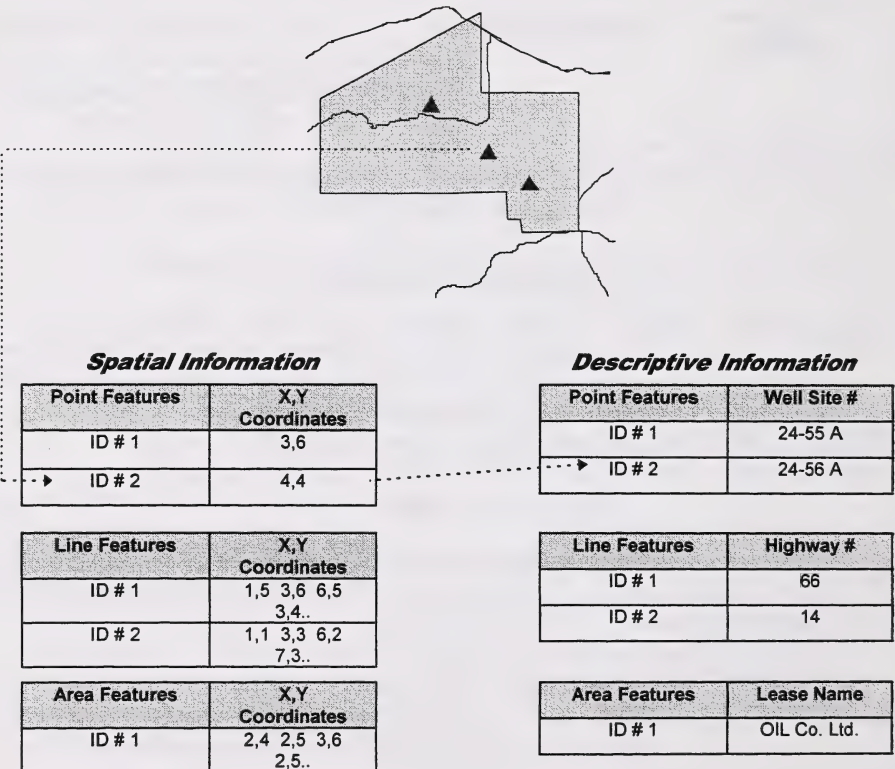
One of the strengths of GIS is the capability to link spatial and descriptive data. Descriptive information or attributes often are stored in a database file containing a unique *key* or link to another database file containing Cartesian Coordinates for each feature. This link enables indexing which speeds queries. One form of databases that

stores information in a series of tables is called a *relational database*. Burrough (1986) reports that:

Relational databases have the great advantage that their structure is very flexible and can meet the demands of all queries that can be formulated using the rules of Boolean logic and of mathematical operations. (p. 18)

One key component of a GIS is the capability of the system to develop and maintain spatial and attribute relationships within features. The following diagram illustrates one type of relationship between spatial and descriptive information in a GIS environment:

In this example, point, line, and area features contain both spatial and descriptive information (not all are shown). These data are displayed in the abbreviated lists below. For each geographic feature there is associated descriptive information based on a unique identifier or key.



Topology is an important concept in GIS and can be defined, in its simplest form, as relative spatial relationships. Bonham-Carter (1994) describes topology as the "relationship between geometric objects remaining constant through any one-to-one continuous transformation" (p. 380). Without topology, the system is merely a digital

representation of Cartesian Coordinates and becomes a mapping tool that follows a Spaghetti Data Model (Aronoff, 1989). Data with topology typically contains arc-node topology, a relationship that expresses an “understanding” of feature adjacency.

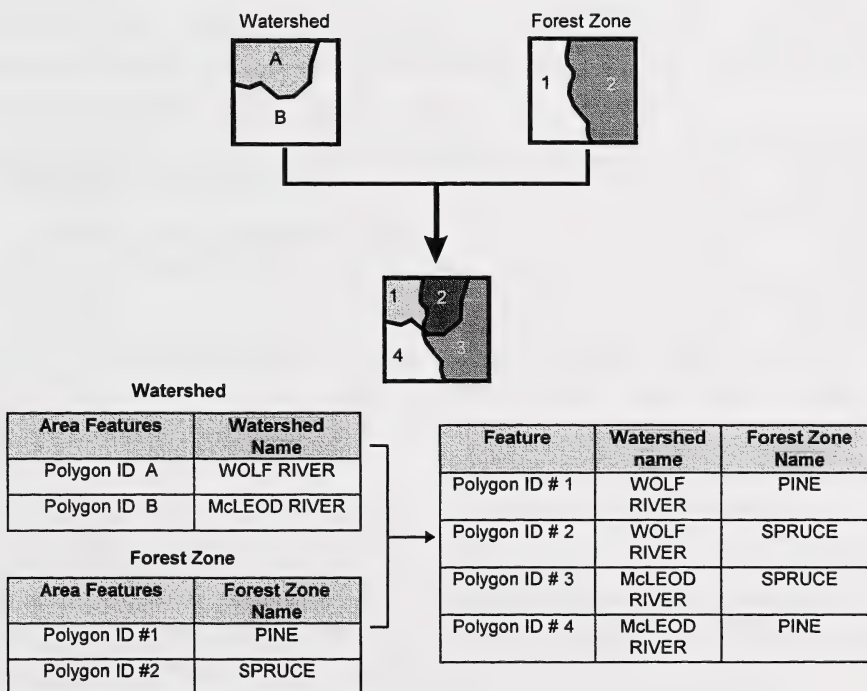
Spatial Analysis

Conceptual Overview

Generally, data preparation prior to analyses is the most time consuming portion of a GIS project; indeed, it may encompass 80% of the project time!

Once data has been entered, edited, and geometric errors have been removed, spatial relationships between features can be examined and analysed. What are the patterns on the landscape and what are the spatial and descriptive characteristics of those patterns? GIS technology permits qualitative and quantitative analyses of spatial and non-spatial attributes.

Spatial analysis may involve a simple frequency summary of features within a particular region or could involve overlaying a number of data “layers” to create new features. The example below illustrates a hypothetical overlay of two polygon layers to create a new, integrated layer containing attributes from both layers.



Decision Support System

Modelling real-life scenarios is one of the more advanced GIS applications. Spatial patterns on the landscape/cityscape can be adapted and analysed in consideration of a myriad of variables. A GIS permits some calculations and scenario building not otherwise possible using traditional mapping and analyses methodology. Although GIS modelling sounds exciting, it is often computationally intense, requires significant user input, and is only as accurate as the baseline information entered and the expert opinion driving a model.

GIS is often used as a tool for prediction. "Prediction in a GIS involves the use of map algebra for defining symbolic models that embody rules for combining data layers together" (Bonham-Carter, 1994, p.6). GIS can be used to predict a variety of outcomes such as potential wildlife impacts of a new facility, or to determine potential fire hazard associated with forest fuel types at different periods of a year.

GIS as a decision support system allows the user to predict a phenomenon(a) as it changes and evolves temporally, independent of and with anthropogenic intervention. As well, changes can and should be controlled and clearly defined in the GIS environment. A host of management scenarios can be fed into the decision support system and the outcomes interpreted. There exists an opportunity to develop new management strategies as well. Using GIS in this sense creates a very powerful, but potentially dangerous tool if misinterpreted. The foundations for the decision support system still require input from experienced personnel, as do the management/treatment scenarios. The end results need to be examined, evaluated, modified (potentially), and integrated with current management thought.

Overview of ArcView®

ArcView is considered a desktop GIS software package that permits users to map and perform simplistic analyses of spatial data. Chapter 2 introduces selected ArcView components and spatial data requirements of the package. Specifically, this chapter examines:

- What is ArcView?; and,
- Spatial Data Structure in ArcView.

This Chapter is not meant to replace the ArcView manual produced by ESRI®; rather, it is intended to synthesise fundamental ArcView concepts from a variety of sources and people. For more detailed information about ArcView, please consult the ArcView online help.

ICON KEY

 Valuable information

 Tips and Tricks

Tech Talk



What is ArcView?

ArcView as a GIS package

ESRI, the creators of ArcView, indicate that ArcView is:

the leading software for desktop GIS and mapping. ArcView gives you the power to visualize, explore, query, and analyze data geographically (p. 1).

In short, ArcView has the capability to perform simple GIS functions and can be “upgraded” to perform more complex spatial analyses with additional add-ons in the form of extensions or scripts. Complex layer overlays and statistical operations can be more difficult or impossible to perform without writing customised programmes within ArcView. Some relatively basic GIS functions, such as buffering, also require scripts or extensions.

Proprietary data storage in ArcView is the shapefile format (these file types will be explored later in the Chapter) which does not have topology. When using this file format, GIS functionality is diminished.

ESRI plans to provide more GIS functionality in its next major release of ArcView (i.e., ArcView 3.1). They will incorporate selected scripts and extensions that have been available via the Internet, but not included in the standard package (e.g., buffering and true overlaying).

ArcView as a Mapping Package

The current version of ArcView may not be a powerful GIS, but it is a powerful data display, query, and output tool; and, a simplistic analysis tool. As ArcView develops more GIS functionality, it may extend beyond a mapping package and become a powerful analytical tool.

Display

One of ArcView's strengths is its ability to rapidly display geographic information in a user-friendly environment, and permit the qualitative analysis of spatial patterns. Legend information can be classified and re-classified quickly using established classification schemes or customised approaches. Patterns on the landscape/cityscape can be visualised or identified, and summarised through charts, tables, or maps.

Explore

Another strength of ArcView is the opportunity it presents to explore one's data. Data may be queried using several methods that will be explored in detail later. Essentially, ArcView supports both its own internal query methods and SQL queries on external databases. Querying permits the isolation of a particular subset or subsets of data. These selected subset(s) can then be visualised or analysed.

Analyse

ArcView supports some simplistic analytical tools and has the capability, through advanced scripting, to perform more complex analyses. Data or subsets of data can be summarised by items, both spatial and/or descriptive, within the database. Simple statistical summaries can be generated and placed into charts or tables for presentation.

Modify

Data can be altered and updated in ArcView in a number of ways. Visual representation of the spatial patterns can be modified to emphasise or de-emphasise a point. In most cases, database and map modification can be accomplished easily and rapidly.

Output

ArcView permits the design, construction, and output of cartographic-quality maps. Many existing software functions permit the creation of maps, figures, and tables that have a professional look-and-feel to them while representing spatial information and patterns in an effective manner. The menus,



An early precursor of SQL was named SEQUEL, which stood for Structured English QUEry Language. Before the product was released, however, IBM found that another company had already copyrighted the word SEQUEL, so they couldn't use it. It was too late to change the name completely, so they just chopped out the vowels and called it SQL. (Taylor, 1998)

toolbars, and inherent functionality make ArcView user-friendly and efficient.

Chapter 3 outlines a step-wise methodology to enable users to create high-quality maps and perform simplistic analyses.

Spatial Data Structure in ArcView

ArcView Projects

When one opens an ArcView session, a *project* is created and an .APR extension file is generated. In general, a project file does *not* contain spatial data layers; rather, it contains pointers to those data layers. For example, a project could contain a pointer to a line coverage and would contain limited spatial information about the layer. This approach is an effective means of reducing data redundancy, ultimately, reducing storage space required for GIS projects. Also, if spatial layers are changed, those changes are reflected in the project automatically.

An image file is a graphic representation or description of a scene, typically produced by an optical or electronic device. Common examples include remotely sensed data (e.g., satellite data), scanned data, and photographs. An image is stored as a raster data set of binary or integer values that represent the intensity of reflected light, heat, or other range of values on the electromagnetic spectrum (ESRI, 1997). One is unable to query image files.

An ArcView project consists primarily of VIEWS, TABLES, CHARTS, LAYOUTS, and SCRIPTS. VIEWS are objects to which one adds existing or creates new spatial data layers, called themes. Themes can be point, line, polygon, raster, or image feature types. TABLES are database files that contain descriptive and/or spatial information (i.e., attributes) about geographic features. Tables can be used to create other tables, charts, and portray maps differently. CHARTS are graphic representations of selected variables within a particular data set or subset. Typical chart types created in ArcView are pie charts, line charts, area charts, and scatter charts. Due to size limitations in the current release of ArcView, one may not be able to chart entire data sets. LAYOUTS are graphic composition pages into which one adds spatial features (e.g., views) and graphic features (e.g., titles). The layout page is where most cartographic elements are added to the project. SCRIPTS are “programmes” written in Avenue, an object-oriented programming language, that enable users to customise toolbars and menus, automate procedures, and create additional functionality within ArcView.

Spatial Data Formats in ArcView

ArcView can display many different data formats; indeed, data from a variety of software companies can be imported or viewed directly within ArcView.

Shapefiles

Shapefiles enable faster display and query, but do not contain topology...



ArcView has an inherent data storage format called *shapefiles*. These can be point, line, or polygon features. Shapefiles are spatially indexed and, as a result, draw quickly and queries may be performed more rapidly than with other data formats. Spatial and descriptive information about shapefiles can be edited in ArcView.

Coverages

ArcView is an ESRI product, and therefore, can handle both PC ARC/INFO® and ARC/INFO® coverages. Coverages are point, line, polygon, and region feature types. Regions are spatial entities that permit nested, associated, and overlapping geographic features to occur within one coverage. These are beyond the scope of this manual. Coverages have the advantage of containing topological relationships within the data; however, one is unable to edit a coverage's spatial entities within ArcView without converting it to a shapefile.

Export Files

PC ARC/INFO and ARC/INFO can export coverages to a platform and operating system independent format called interchange files. Typically, these files are referred to as E00 files because the extension for these files is .E00. ArcView contains a stand-alone programme that converts interchange files to PC ARC/INFO coverages or ARC/INFO coverages, depending on which utility is used. Once imported, the data can be added to a project as a coverage.

CAD Files

ArcView comes bundled with a very useful extension that permits the use of AutoCAD [.DXF and .DWG (Windows only)] and Microstation (.DGN) files. One advantage of using the CAD reader extension is that the CAD files are not converted, but rather "read". This reduces data redundancy on one's system. Manipulation of CAD files once in ArcView is limited, but one can convert these files to shapefiles if more functionality is required.

Image Files

Image files can be read by ArcView; however, manipulation or analyses of the data is very limited. Spectral reflectance values cannot be queried, but display properties can be modified. ArcView reads the following image formats: TIFF, TIFF/LZW compressed, ERDAS, IMAGINE (if ArcView's IMAGINE image extension is loaded), BSQ, BIL, BIP, Sun rasterfiles, BMP, Run-length compressed files, JPEG (if ArcView's JPEG image extension is loaded), Image catalogs, or GRID.

GRID Files

GRID data are unique because they can be read by ArcView either as an image, that does not permit attribute query and analyses, or as a GRID that does. With the Spatial Analyst extension, one is able to not only visualise raster information, but also to analyse it.

Other Files

ArcView can import other data formats that are beyond the scope of this manual [e.g., MapInfo® Interchange Format (MIF) files]. ASCII Cartesian Coordinates can be read into ArcView as EVENT THEMES if desired. There are a number of scripts in existence that permit the import of other formats as well. The Internet is the best place to search for those scripts.

Deciding on the most suitable data format for your organisation is important. Each format has advantages and disadvantages and it may be a combination of data formats that is desired or required.

Tabular Data Formats

ArcView handles a number of tabular data formats including: dBASE, INFO, and delimited text files. In addition to these formats, ArcView can connect to SQL servers.

dBASE Files

ArcView handles dBASE version III and version IV. The dBASE file format is a common database format that can be used in a number of spreadsheet and database packages such as Microsoft Excel®. This is the spatial and descriptive database format used in PC ARC/INFO and can be translated in ARC/INFO.

INFO Files

INFO is the database system built into ARC/INFO that stores both spatial and descriptive attributes. These files reside in an INFO directory in the workspace.

Text Files

ArcView can import text files, both comma and tab delimited. The first line in the text file should contain the field names (i.e., items) for the table. Fields with values containing only numbers are treated as numeric fields. Fields with *any* characters that are not numbers are considered string format. Strings can either be quoted or unquoted.

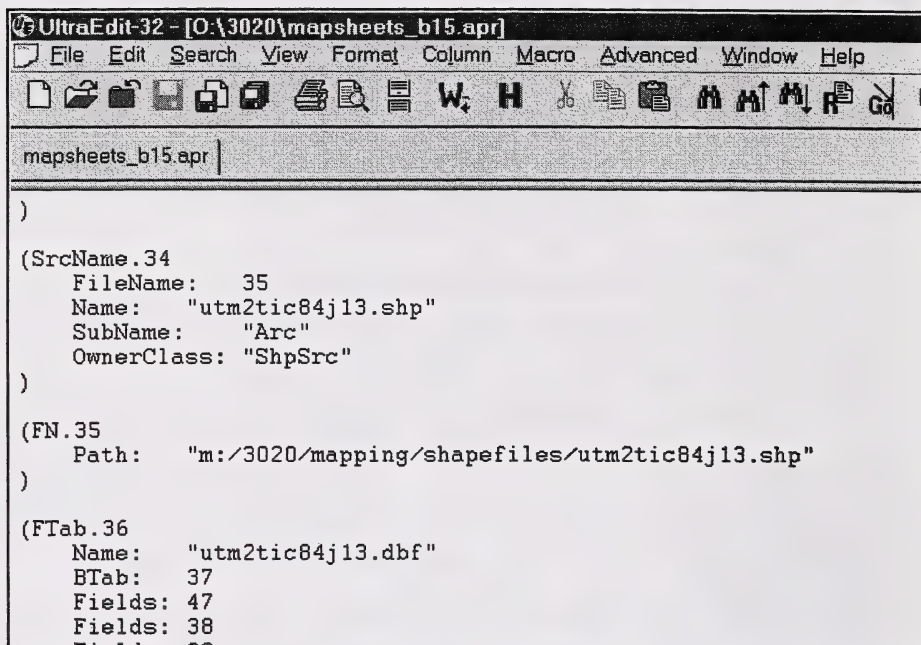
ArcView uses the dBASE format as its standard table format. When one creates a shapefile or a new table, it is saved in dBASE format by default.

APR Files

Project files, or APR files, are text files that contain a series of pathnames and file references to spatial information. Other information stored in APR files includes information about each view (e.g., projection, scale, legend, etc.), additional text, symbols, graphics, colour schemes, pointers to palettes, and other internal ArcView commands that describe the setup and look-and-feel of a project. An APR file that points to specific hard drive locations will not necessarily work on another machine without some modification. Because APR files are text files, a text editor such as

Text files are the most versatile format for tabular data because they can be platform independent. Text format, however, is very inefficient and not recommended as a "working" format. dBASE files are quite common and are an efficient means of storing data. Each format has advantages and disadvantages...you may use a combination of formats to meet your needs!

UltraEdit™ can be used to modify the file to point to new file locations. The example below is a section from an APR file:



```

)
(SrcName.34
  FileName: 35
  Name: "utm2tic84j13.shp"
  SubName: "Arc"
  OwnerClass: "ShpSrc"
)
(FN.35
  Path: "m:/3020/mapping/shapefiles/utm2tic84j13.shp"
)
(FTab.36
  Name: "utm2tic84j13.dbf"
  BTab: 37
  Fields: 47
  Fields: 38
  Fields: 38

```

Reference path names are embedded in the APR and can be edited to point to a new path location if the project is transported to a different machine. For example, if data were copied to a local drive (e.g., C:) then one would be required to do a global search-and-replace for M: drive. Notice that regardless of the operating system in use, directory separators are always forward slashes (i.e., "/").

It is not recommended that the APR be edited for other purposes (e.g., removing features) and any edits should be done on a backup copy in case of file corruption.

Summary

ArcView is a desktop GIS that permits users to use their data to visualise patterns, query information, update data, perform simplistic spatial analysis, and generate cartographic output. The software imports and directly reads a variety of spatial and descriptive data formats and can export to a number of external formats. The APR file is the "master file" that controls *what* data is included in one's project and *how* that data is displayed. For more specific information on ArcView's data requirements and storage formats, please refer to the online help available within the software.

Workshop Data Sets

EOP3 Project Background

The Alberta EOP3 project is a joint initiative between Alberta Environmental Protection, Resource Data Division (RDD), and the Canada Centre for Remote Sensing (CCRS). The objective of the project is to develop a multi-user image-based ground cover classification scheme using Landsat Satellite imagery with the intent of producing regional land cover maps at a scale of 1:50,000.

The project's success is highly dependent on available ancillary data for registration of satellite imagery and classification of land covers including provincial base mapping, digital terrain data, AVI data, air photos and Permanent Sample Plot data.

All classified and ancillary data for the project was supplied using a Universe Transverse Mercator (UTM) projection, in either Zone 11 or Zone 12, using NAD 27 (North American Datum 1927).

Satellite imagery was purchased to ensure coverage of each of the province's Natural Regions and Subregions. A total of three full, and twelve quarter Landsat TM scenes were purchased. Regional staff were asked to select three priority areas from the available imagery. Subsequently, one NTS mapsheet (Scale 1:50,000) was selected from the area with greatest priority for purposes of classification and mapping. (Figure 3.1). Priority sites were classified using the PCI image analysis software and mapped using the GIS software ArcView.

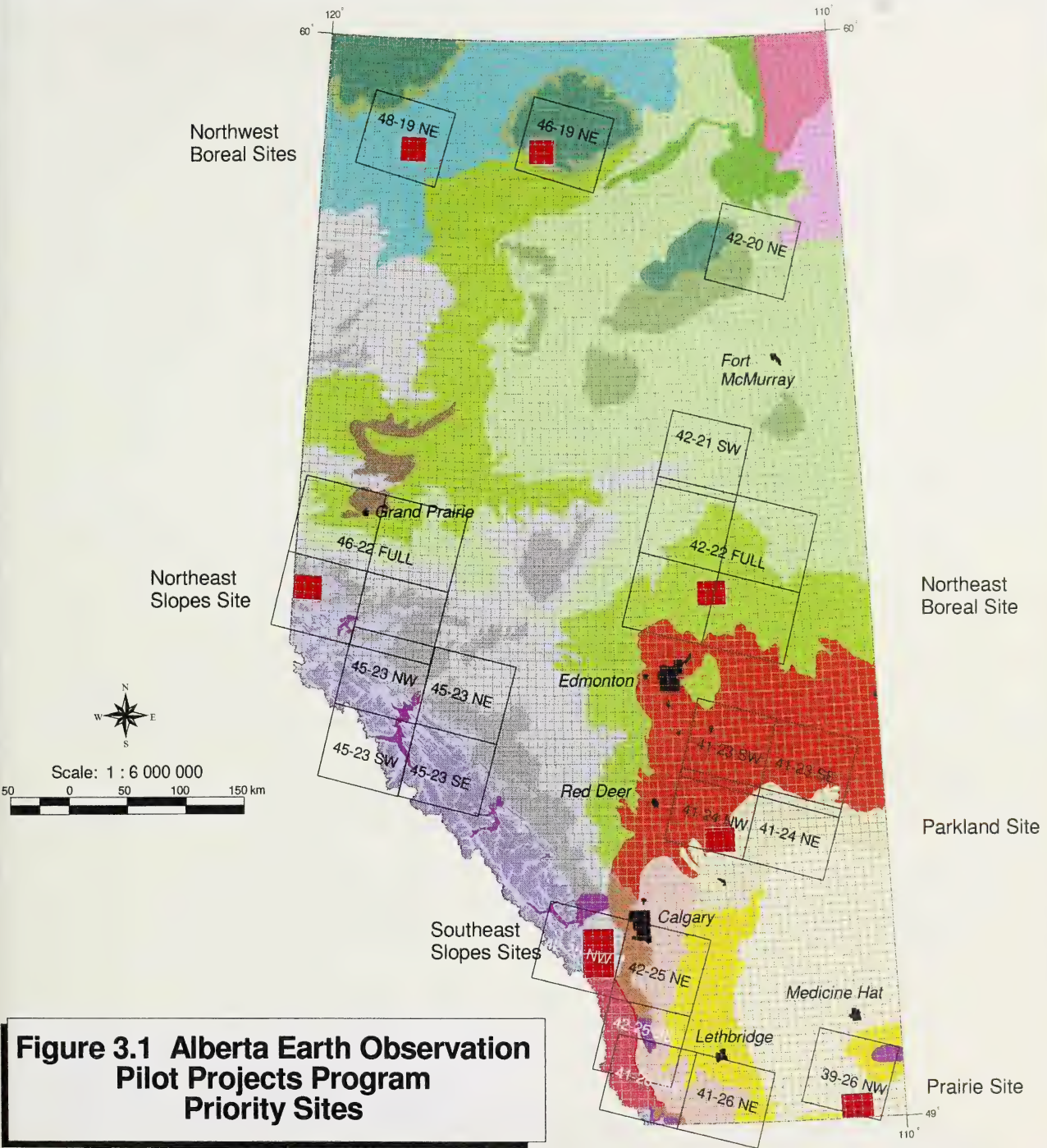
Two notable exceptions occurred. In the Northwest Boreal Region, two quarter scenes of Landsat TM imagery were classified, and two 1:50,000 NTS maps sheets selected for purposes of mapping. In the Southeast Slopes Region, two rather than one, 1:50,000 NTS mapsheets were selected for purposes of classification and mapping.

ICON KEY

 Valuable information

 Tips and Tricks

 Tech Talk



MAP INFORMATION

SOURCE: Natural subregions provided in digital format by Alberta Environmental Protection, Resource Data Division

MAP PROJECTION: Transverse Mercator (10 Degree TM)

DATUM: NAD 27

SPHEROID: Clarke 1866

Natural Subregions

- | | |
|----------------------|----------------------|
| Alpine | Central Mixedwood |
| Sub-Alpine | Dry Mixedwood |
| Montane | Wetland Mixedwood |
| Upper Foothills | Sub-Arctic |
| Lower Foothills | Peace River Lowlands |
| Athabasca Plain | Boreal Highlands |
| Kazán Upland | Dry Mixedgrass |
| Foothills Parkland | Foothills Fescue |
| Peace River Parkland | Northern Fescue |
| Central Parkland | Mixedgrass |

LEGEND

Additional Features

- Priority Site
- Follow-up Site
- Landsat Path and Scene Reference



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GIS and cartography by K. Mott and R. Taylor

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Project deliverables will include the following:

1. a description of the classification scheme including representative image examples and ground photos where available, as well as a discussion as how the system was developed to meet client and regional goals;
2. a description of the classification techniques evaluated and tested during the project, along with a final set of procedures to be used for future operational classification and updating. This will include both image analysis and GIS-based tasks;
3. a detailed description of procedures used to verify accuracy levels, including the use of ancillary data, to verify levels of accuracy;
4. a description of prototype output products generated during the project and an evaluation of those products by clients; and
5. a description of follow-up marketing activities undertaken by the contractor using experience gained from this initiative.

Northwest Boreal Region

Classified Imagery

Two Landsat quarter scenes were classified in the Northwest Boreal Region, from which two priority sites, the Northwest and Northcentral, were selected for mapping. The Northcentral site has been selected for purposes of this course. It corresponds to NTS Mapsheet 84 J/13.

This site was significantly affected by forest fires in the central part of mapsheet in 1995 and by fires in the northwest portion of the mapsheet in 1982. The site is found along the edge of the Subarctic and Boreal Highlands Subregions. The topography of this site is dominated by the Caribou Mountains and Margaret Lake in the northeast.

With the help of Cordy Tymstra at the Forest Protection Branch, the land cover classes were reclassified into forest fuel types in accordance with the National Fire Behaviour Prediction classification scheme.

Ancillary Data

Due to the remote location of the area, roads were not present in the priority site. As a consequence, hydrology was the single data set used to register the satellite imagery. Land cover was classified using field data collected specifically for the project. The minimum land area mapped was two hectares.

This area illustrates the importance of incorporating coordinate systems into the map to provide the viewer a reference base. Due to the importance of the area for forestry, forest management unit boundaries were incorporated as a map layers. Seismic lines also were included.

Southeast Slopes Region

Classified Imagery

The priority site selected for the Southeast Slopes region was Bragg Creek. This site, includes the area covered by two adjacent NTS Mapsheets 82 J/15 and 82 J/10. The Bragg Creek data set used for this course is NTS Mapsheet 82 J/15. With the help of Rigel Oil & Gas Limited, GAIA/Geomatics will be classifying a significant portion of the Montane Subregion within the Southeast Slopes Region (Rigel Site, Figure 3.1).

The site is a mountainous region comprised of parts of the Alpine, Subalpine and Upper Foothills Subregions. The Elbow River flows through the middle of the mapsheet. This presents a number of classification problems. Shadows are often present making classification based on spectral differences difficult. In such an environment it is also difficult to extract hydrography from the imagery due to the volume of riparian growth and tree height.

Ancillary Data

The proximity of the site to Calgary ensured there was ample linear ancillary data in the forms of roads and hydrography to register the satellite imagery. The location of mountain peaks also was used. AVI data was the ancillary data used to classify land cover. The minimum land area mapped was two hectares.

Prairie Region

Classified Imagery

The priority site selected for the Prairie Region was the Milk River/Kennedy Coulee site which corresponds to NTS Mapsheet 72 E/2 (Calib Coulee mapsheet) in UTM Zone 12. The site occurs primarily in the Dry Mixedgrass Subregion with the southwest corner including the Mixedgrass Subregion.

It is located on the Canada/U.S. border and is dominated by the Milk River and its floodplain area. The site is significantly affected by agriculture. The greater area includes three provincial grazing reserves, the Onefour Research Substation and the Milk River Provincial Natural Area.

Ancillary Data

Roads and hydrography data were used to register the satellite imagery and air photos interpreted specifically for the project were used to classify land cover. Due to the complexity of land cover, the minimum land area mapped was 0.5 hectares.

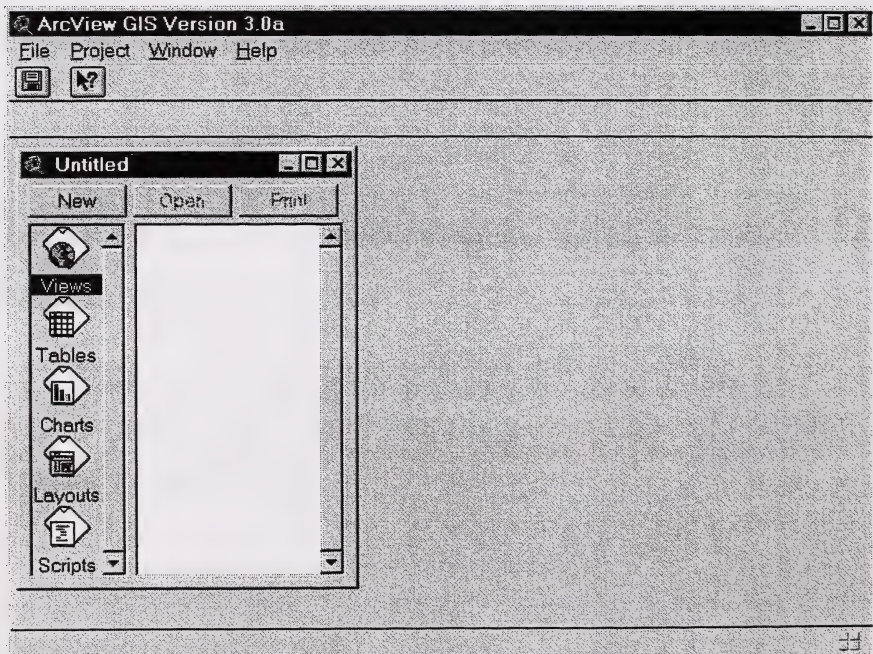
Components of an ArcView Project

The examples used throughout this manual are meant for beginning ArcView users. Many important features of the software are introduced and explained; however, many advanced components are not discussed. Any elements not reviewed in this manual may be found in the ArcView on-line help or if available, the manual entitled *Using ArcView GIS*.

Beginning an ArcView Project

Project Window

By double-clicking on the ArcView icon or by selecting ARCVIEW GIS VERSION 3.0A PATCH from the Windows Start Menu, the program launches and the *Project Window* is opened.



All major components of the project are managed from this window. ArcView loads a new project automatically, but a user can open an existing ArcView project by selecting OPEN PROJECT from the FILE menu. Components of an ArcView project include *Views*, *Tables*, *Charts*, *Layouts*, and *Scripts*—each appearing as a separate icon in the Project Window. These components manage spatial, descriptive, and programme data in their respective windows and are described in detail in the following sections.

Menus and Toolbars

File

Click here to create (NEW), OPEN, CLOSE, and SAVE a project. You also can load ArcView Extensions for a particular project. Extensions increase the functionality within ArcView.

Project

Permits access to the PROPERTIES of a project including comments, and can specify a script to load at the STARTUP or SHUTDOWN of a project.. Advanced features include CUSTOMIZE where one can edit menus and toolbars. The IMPORT option allows a user to open older versions of ArcView projects.

Window

Allows a user to organise multiple windows on screen. ArcView allows multiple windows from different components to be open at the same time.

Help

From here you can obtain online help.



SAVE - Saves the current project



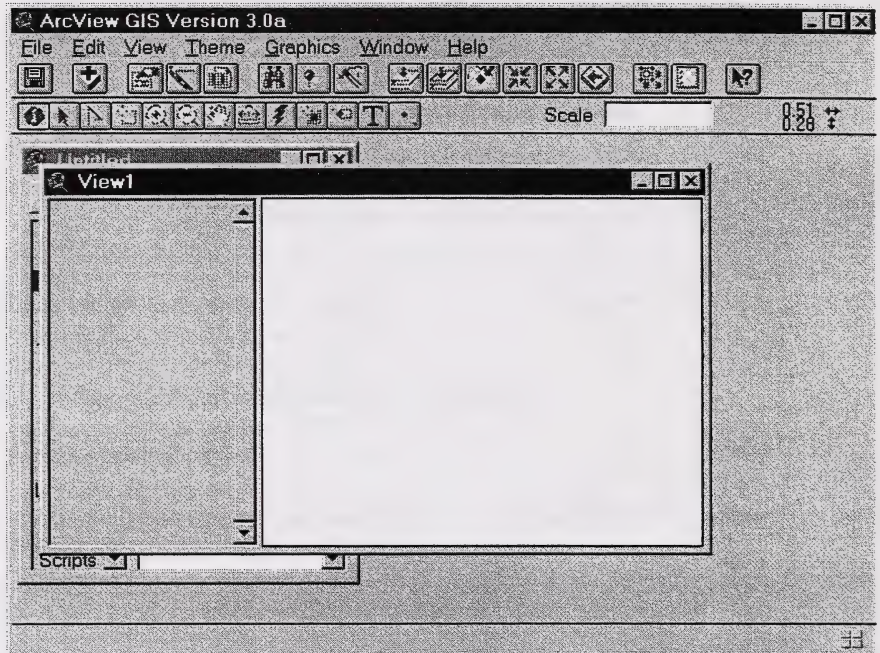
HELP - Click on this, then select the button, tool, or menu choice you want help about.

Tips and Tricks

It is a good idea to save a new project immediately, even before adding any data. Also, it is good practice to save frequently. With the amount of effort put into a project, this can save time and frustration associated with re-creating a project in the event of a system crash and consequential data corruption.

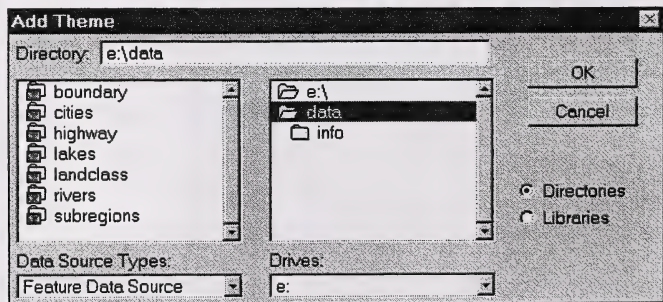
Working with Views

With the VIEW icon highlighted in the project window, click NEW, or simple double-click the view icon. The *View Window* will open with associated menus and toolbars. It is in this window that spatial data is added, queried, manipulated, and analysed.

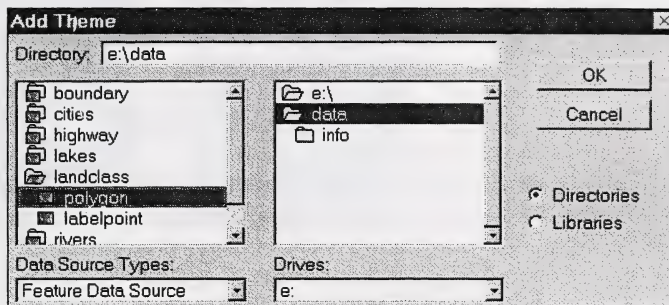


Adding Spatial Data

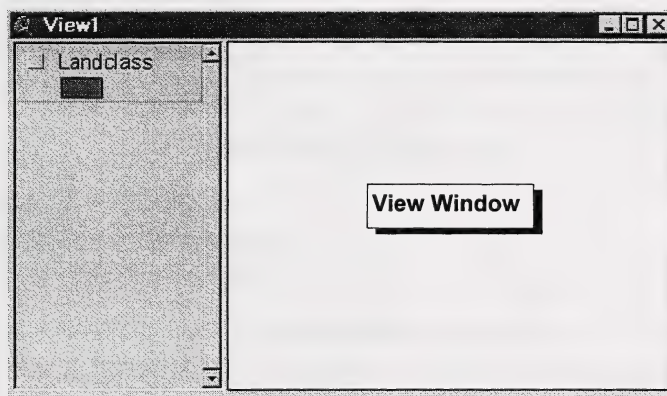
To add a theme select ADD THEME from the VIEW menu, or click the add theme button . The *Add Theme Window* will appear, allowing you to search directories on local drives or network drives, if mapped.



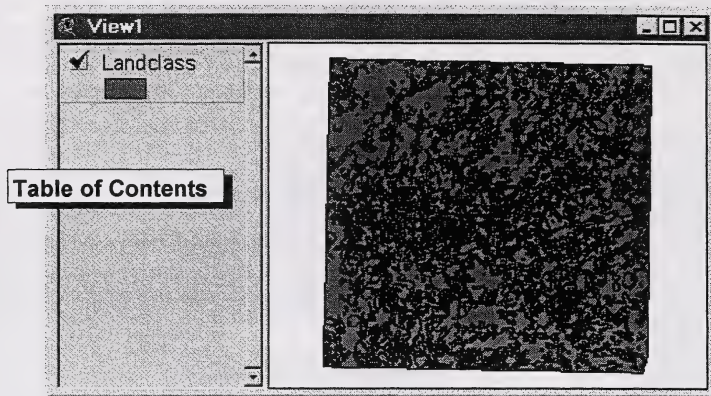
The menu in the right menu indicates the path and associated drive currently being explored. You can change the drive letter from the DRIVES pull-down menu. The left menu lists existing coverages, shpaefiles, and CAD files (if the CAD extension is loaded) within the directory. Beside each spatial file name is an icon indicating if more than one feature type exists. For example, clicking on the folder icon beside *landclass* displays all themes that are available. When a coverage is highlighted without selecting a specific theme, ArcView defaults to the first theme of the list.



In this case, *polygon*, and *labelpoint* themes exist for the *landclass* coverage. Double-clicking on *polygon* will open the theme in the view window.



Each theme has a check box to its left which indicates whether the theme is currently drawn in the view. You control which themes are drawn in a view by checking these boxes.



Each theme appears in the *Table of Contents*. The Table of Contents performs several functions relating to how themes appear in the view window, including:

The theme name

Theme names are representative of the data source, such as 'Landclass'. You can give themes longer, more descriptive names by selecting **PROPERTIES** from the **THEME** menu and retying the name in the **THEME NAME** box.

The legend for each theme

A theme's legend displays the symbols, colours, and patterns used to draw the theme. By using the **LEGEND EDITOR**, a theme's symbol can be altered to suit the needs of the user.

The order the themes are drawn in the view

If more than one theme exists in the Table of Contents, the theme at the top is drawn last, or on top of those below it. Drag themes up and down the Table of Contents to change the order they are drawn.

Which themes are active

A theme must be active in order to alter, query, or analyse it. A theme is made active by clicking on the theme name or legend. Multiple themes can be made active by holding down **SHIFT** when clicking on the them.

Which theme is editable

A dashed line around the theme's check box indicates the theme is currently being edited. Only *shapefile* themes can be edited in ArcView.

Hiding the Table of Contents

To hide the Table of Contents, drag its right border all the way to the left. Drag its border back to the right when you want to see it again.

Hiding a theme's legend

When you have several themes in your view, the Table of Contents may become crowded and hard to edit. You can save space by hiding legends for one or more of the themes. To hide a theme's legend, make the theme active and then choose HIDE/SHOW LEGEND from the THEME menu. The name and check box remain visible, but class details are not visible when a legend is hidden.

Cutting, copying, and pasting themes

One can have more than one view open at one time. A time-saving procedure for working across multiple views is to copy and paste themes. All revisions made to a theme carry over from one view to another.

Menus and Toolbars



SAVE - Saves the current view.



ADD THEME - Allows you to add one or more themes to the view.



THEME PROPERTIES - Lets you change the properties of the theme.



EDIT LEGEND - Lets you change how the active theme is displayed.



OPEN THEME TABLE - Opens the attribute table for the active theme(s) in the view.



FIND - Finds a feature in a view, table, or chart that has the value you type in.



LOCATE ADDRESS - Locates a specific address in the active theme(s)



QUERY BUILDER - Queries data according to attributes via a query expression



ZOOM TO FULL EXTENT - Zooms to full extent of all themes.



ZOOM TO ACTIVE THEMES - Zooms to the extent of the features in the active theme(s).



ZOOM TO SELECTED - Zooms to the extent of the currently selected features in the active theme(s).



ZOOM OUT - Zooms out by a factor of 2.



ZOOM IN - Zooms in by a factor of 2.



ZOOM TO PREVIOUS EXTENT - Goes back to the previous extent you were viewing.



SELECT FEATURES USING GRAPHIC - Selects features from the active theme(s) located under the currently selected graphic(s) drawn on the view.



CLEAR SELECTED FEATURES - Deselects selected features in the active theme(s).



IDENTIFY TOOL - Displays the attribute values of a feature shown in a view, table, or chart.



POINTER TOOL - Selects, moves, and resizes graphics.



VERTEX EDIT TOOL - Reshapes a feature or graphic by moving, adding, or deleting vertices.



SELECT FEATURES TOOL - Selects features from the active theme(s) in the view.



ZOOM IN TOOL - Zooms in based on a position or area defined with the mouse



ZOOM OUT TOOL - Zooms out based on a position or area defined with the mouse.



PAN TOOL - Pans across the view by dragging the display with the mouse.



MEASURE TOOL - Measures distances on a view.



HOT LINK TOOL - Follows a hot link by clicking on a feature in the active theme.



AREA OF INTEREST TOOL - Sets the area of interest for a view containing library-based themes.



LABEL TOOL - Labels a feature in the active theme.



TEXT TOOL - Adds or edits text in a view

Drawing and Editing Tools



Draw a point



Draw a straight line



Draw a line with two or more vertices

-  Draw a rectangle
-  Draw a circle
-  Draw a polygon
-  Draw a line to split line features
-  Draw a line to split polygon features
-  Draw a line to append a new polygon adjacent to other polygons

Issues of Projection & Scale

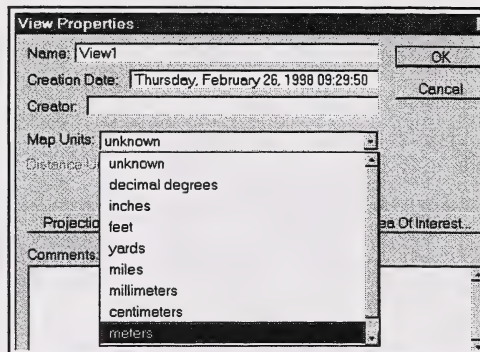
Map scale is the relationship between the dimensions of a map (digital or hardcopy) and the dimensions of the Earth. It is usually expressed as a ratio between a distance on the map and a distance on the Earth. In ArcView, scale must be established before distances can be measured and view extent can be set.

To set the scale, select PROPERTIES from the VIEW menu. The *View Properties Window* appears, with options to add descriptive information about the creation of a view. The projection for a view also is set here, but only applies if the spatial data appearing in the view is stored in decimal degrees. The spatial data used as examples in this manual are projected in Universal Transverse Mercator (UTM Zone 11); therefore, defining the projection in the view is not necessary.

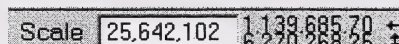
To establish a scale for a view, designate the *Map Units* and *Distance Units*. Map units are the units in which the coordinates of the spatial data contained in the view are stored. ArcView uses the map units setting to determine the correct scale of a view. If the map units are not set correctly, the scale displayed for the view may be incorrect, and ArcView will incorrectly draw the view when a scale is specified.

Distance units are the units used by ArcView to display or indicate the result of measurements made in the View. Typically, these units will be the same as the map units.

For the examples in this manual, both map and distance units are selected as *metres*. To set these, select PROPERTIES from the VIEW menu. Click on the MAP UNITS pull-down menu and select the units for the view. After this, choose the same units in the DISTANCE UNITS pull-down menu.



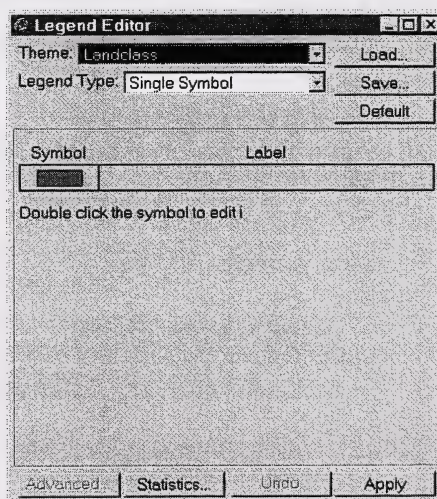
Click OK and the view will reappear with the scale displayed in the *Scale* window with X,Y values to the right.



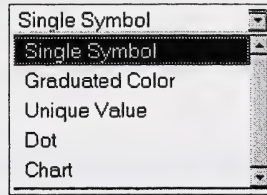
Now the scale can be specified by simply typing the number in the scale window. It is important to note that the scale of theme(s) in the view are affected by the size of the view window itself. If the view window is resized, the redrawn themes will appear at a different scale, and the value in the scale window will reflect this change.

Classifying Spatial Data

The attributes present in a themes database can be used to reclassify the theme. To perform this task, double-click on the active theme in the Table of Contents. The *Legend Editor* window will appear:



From this window one can reclassify theme attributes based on different classification methods, all of which are chosen from the LEGEND TYPE drop-down menu



Single Symbol

All features in the theme are displayed with the same colours and symbols.

Graduated Colour

All features are displayed with the same symbol type, but colours represent a progression of values for a specified attribute.

Graduated Symbol

All features are displayed with the same colours and symbols, representing a progression of values.

Unique Value

Features are displayed with the unique colours and symbols.

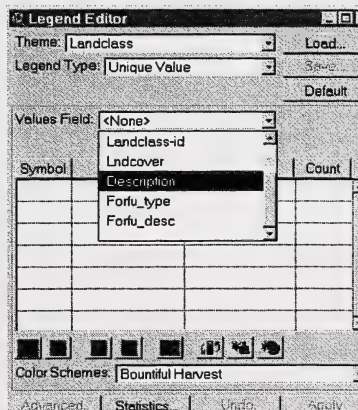
Dot Density

Features of a polygon theme are displayed with a number of dots corresponding to a specified attribute value.

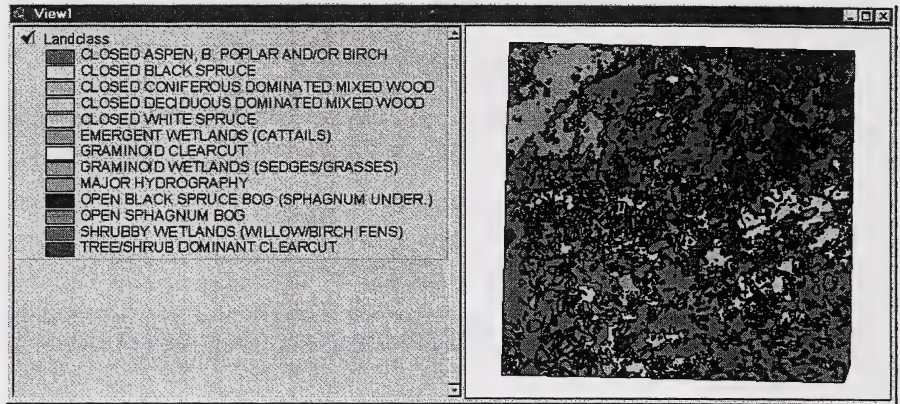
Chart

Features are displayed with an associated pie chart or column chart.

In our example, the landclass theme is classified by unique value. Selecting this option brings up a *legend table* where reclassified values will be displayed for editing purposes. Before anything appears, the reclassification field must be selected from the VALUES FIELD drop-down menu.

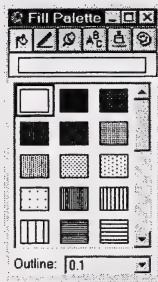


The Values Field menu displays field names applying to the currently selected theme. The field '*description*' is selected from the list and each unique value appears in the table. Click APPLY to execute the reclassification. ArcView redraws the theme in the view window with the classes, and their associated symbology appearing in the Table of Contents. The following image shows the reclassified theme.



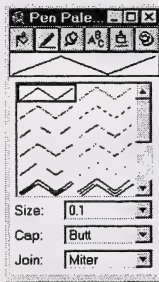
Legend Editing

The *Symbol Window* is an interface where legend features, graphics, and text can be customised. The symbol window is universal across Views, Charts, and Layouts. To start the symbol window, simply double-click on the feature you want to edit or select SHOW SYMBOL WINDOW from the WINDOW menu.



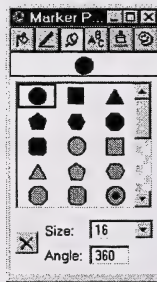
FILL PALETTE

This window allows you to change the appearance of fills and outlines of polygon features or graphics.

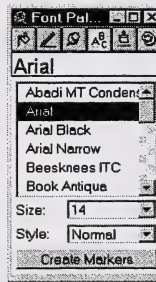


PEN PALETTE

This window allows you to change the appearance of linear features or graphics.

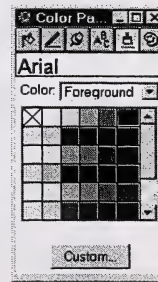
MAKER
PALETTE

This window allows you to change the appearance of point features or graphics.

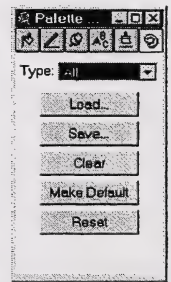


FONT PALETTE

This window allows you to change the appearance of text features or graphics.

COLOUR
PALETTE

This window allows you to change the colour of the previous types of features or graphics.

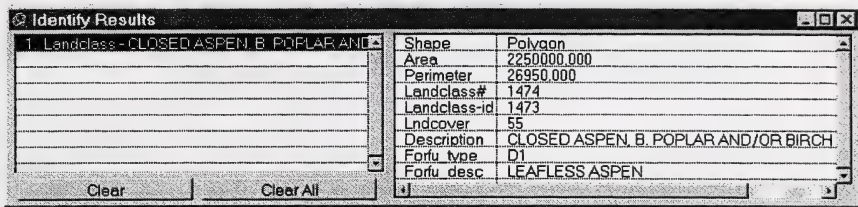
PALETTE
MANAGER

This window allows you to customise all palettes except fonts.

Use one or a combination of several palettes to edit how spatial data is displayed.

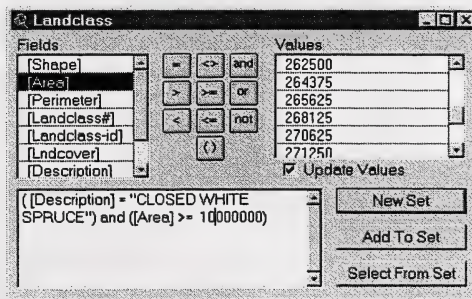
Identifying Attributes

ArcView is a strong tool for identifying attributes of spatial data quickly, easily, and effectively. In the view, click the identify button , then select a feature on screen to identify attributes for that theme. ArcView generates a simple report appearing in the *Identify Results* window, showing attributes for the selected feature. If necessary, the window can be resized to display more data.



Re-selecting Spatial Data

ArcView is capable of determining where certain conditions apply. Using the *Query Builder*, spatial data can be reselected based on a set of arguments specified the user. In this example, areas of Closed White Spruce greater than 10 km² need to be identified and highlighted. Clicking on the query builder button  launches a window where expressions are entered via typing or double-clicking on field names, mathematical/logical operators, and values.



To execute the expression click on NEW SET. In the view window the theme will highlight features that meet the requirements of the expression. Use the ZOOM TO SELECTED  button in the view to draw the re-selected features close-up.

Multiple queries can be performed by either adding to existing selected data sets (ADD TO SET), or reselecting from existing data sets (SELECT FROM SET). To clear a set

of selected data click on the CLEAR SELECTED SET  button in the view window.

Labelling Features

In many instances, descriptive labels are required to help distinguish features from each another. ArcView is able to perform this task, although some practice is required to display the labels in a useful format. ArcView allows a user to label features with any attribute existing for a theme. Prior to labelling, there are a number of important steps and factors to consider.

Use the *labelpoint* theme of the coverage you want to label.

By using the *labelpoint* theme, one has greater control over label placement. If necessary, the *labelpoint* symbol for any theme can be edited so it will not display on-screen.

At what scale will the labels be displayed?

Labels added at a scale different from what the final map is displayed will affect how they appear. If your final map product is represented at a scale of 1:250 000, your labels should be added in the view at the same scale.

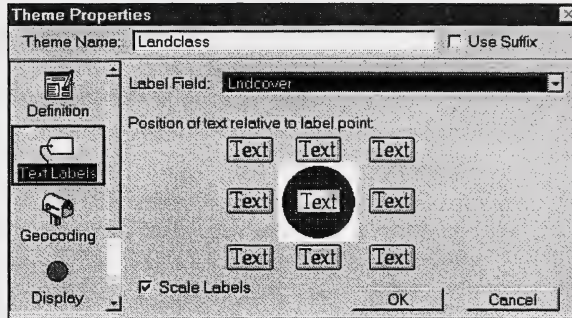
Which font and what size will the labels be displayed?

The default font in ArcView may not be suitable for displaying labels effectively in a view. The font and size should be set prior to labelling.

How intricate is the network of features?

Labels added to a dense network of polygons or arcs will require additional editing. ArcView does not adjust the size or position of labels based on the shape or orientations of the feature, so resizing and rotation of labels is often necessary.

ArcView requires the user to select a field for labelling from the theme's data set. The attributes of the field are used to label each feature. Select the *labelpoint* theme in the Table of Contents, then select PROPERTIES from the THEME menu, or click the theme properties button .



In the LABEL THEME drop-down menu, select the attribute to be used for labelling. The position of the label relative to the labelpoint or cross-hair (if placing labels manually), can be customised by selecting one of the 'TEXT' buttons.

Once the properties are set, select auto-label from the theme menu. This window offers more options to customise how labels will be placed. Select USE THEME'S TEXT LABEL PLACEMENT PROPERTY to apply the previous settings from the Theme Properties window. Click OK and all features selected in the theme will be labelled by the selected attribute.



The other method of labelling is to use the LABEL TOOL . Click this button, then click on the feature you want to label. This method is useful when there are a small number of features to label or if one wishes to label larger features more than once.

Tips and Tricks

You can identify (i.e., query) more than one theme at the same time. Select multiple themes while holding the SHIFT key. ArcView will “drill down” into each theme and return attribute information for each feature identified in each selected theme.

Turn off all themes when editing a legend. This saves time because themes do not refresh on-screen each time a change is applied to a legend.

Custom palettes are included with ArcView. They are located in the directory `esri\av_gis30\arcview\symbols` and are loaded from the *Palette Manager* in the *Symbol Window*. Remember to save revisions to the palette by selecting SAVE or, if you want the revised palette to load every time, select MAKE DEFAULT.

Working with Tables

Tables are used to identify, query, and manage spatial data. These processes are important in a GIS as summaries and statistical reports are often required.

ArcView offers a powerful interface for working with tables. The following examples in this section demonstrate basic tables capabilities. These examples, however, reflect likely scenarios encountered in developing an ArcView project.

Adding Attribute Data

The most common tabular data used in ArcView are feature attribute tables or theme attribute tables. To open a theme's table select the theme in the view then click the OPEN THEME TABLE button . A table with the fields and attributes for the selected theme appears.

Attributes of Landclass								
Shape	Area	Perimeter	Landclass	Landclass-id	Landcover	Description	Fortu type	Fortu desc
Polygon	249421.344	4952.843	2	1	83	SHRUBBY WETLANDS 01B	NON-FUEL	
Polygon	21199.809	947.979	3	2	82	GRAMINOID WETLAND NF	NON-FUEL	
Polygon	54550.000	1924.045	4	3	82	GRAMINOID WETLAND NF	NON-FUEL	
Polygon	4263862.500	56793.707	5	4	83	SHRUBBY WETLANDS 01B	NON-FUEL	
Polygon	19397.500	827.055	6	5	82	GRAMINOID WETLAND NF	NON-FUEL	
Polygon	52763056.000	281059.031	7	6	82	GRAMINOID WETLAND NF	NON-FUEL	
Polygon	681.680	104.536	8	7	83	SHRUBBY WETLANDS 01B	NON-FUEL	
Polygon	43370.742	1786.629	9	8	83	SHRUBBY WETLANDS 01B	NON-FUEL	
Polygon	775.000	131.010	10	9	83	SHRUBBY WETLANDS 01B	NON-FUEL	
Polygon	2281.250	227.515	11	10	83	SHRUBBY WETLANDS 01B	NON-FUEL	
Polygon	78137.086	2673.034	12	11	83	SHRUBBY WETLANDS 01B	NON-FUEL	
Polygon	26768.023	961.087	13	12	82	GRAMINOID WETLAND NF	NON-FUEL	
Polygon	40662.500	1506.852	14	13	83	SHRUBBY WETLANDS 01B	NON-FUEL	
Polygon	274044.531	5528.645	15	14	83	SHRUBBY WETLANDS 01B	NON-FUEL	
Polygon	13825.000	767.531	16	15	82	GRAMINOID WETLAND NF	NON-FUEL	
Polygon	14031.688	851.606	17	16	82	GRAMINOID WETLAND NF	NON-FUEL	
Polygon	6273.836	350.480	18	17	82	GRAMINOID WETLAND NF	NON-FUEL	
Polygon	55093.750	1924.036	19	18	82	GRAMINOID WETLAND NF	NON-FUEL	
Polygon	5081.250	385.515	20	19	83	SHRUBBY WETLANDS 01B	NON-FUEL	
Polygon	87637.500	2329.036	21	20	83	SHRUBBY WETLANDS 01B	NON-FUEL	
Polygon	169400.000	2761.076	22	21	83	SHRUBBY WETLANDS 01B	NON-FUEL	
Polygon	1835193.750	29490.125	23	22	83	SHRUBBY WETLANDS 01B	NON-FUEL	
Polygon	20543.750	820.535	24	23	82	GRAMINOID WETLAND NF	NON-FUEL	
Polygon	8375.000	460.026	25	24	53	CLOSED WHITE SPRUCE	BOREAL SPRUCE	
Polygon	28014.375	1123.213	26	25	82	GRAMINOID WETLAND NF	NON-FUEL	

Field names appear across the top row with individual records listed in the rows below. Fields can be selected individually to perform specific data summaries. Tabular data can be imported from other sources including dBASE, INFO, delimited text files, or new tables can be created to link existing data sets.

Menus and Toolbars

Toolbar buttons which have been previously described do not appear in subsequent lists.



CUT - Cuts the data from the active cell



COPY - Copies data in the active cell.



PASTE - Pastes the selection you cut or copy.



SELECT ALL - Highlights all records within the table.



SWITCH SELECTION - Switches selected and unselected records in the table.



CREATE CHART - Creates a chart from data in the active table.



PROMOTE - Brings all selected records together at the top of the table.



JOIN - Joins another table to the active table, using the values of a common field in both tables.



SUMMARISE - Summarises the active table, using the active field. A new table is created for this new data.



CALCULATE - Calculates the values in the active field using the expression you want.



SORT ASCENDING - Sorts records in the active field, beginning with the lowest number, first letter of the alphabet, or the earliest date.



SORT DECENDING - Sorts records in the active field, beginning with the highest number, the last letter of the alphabet, or the latest date.



EDIT - Edits the records in a table.

Table Properties

In the *Table Properties* window, field visibility can be set. When data is queried and only a subset of the fields are visible, remaining fields are "hidden" in the results window. This feature may be useful when examining large databases with many fields and one wishes to view specific data fields.

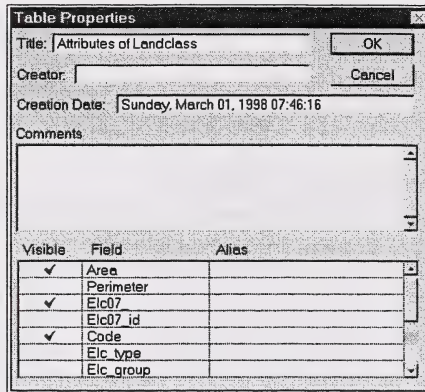


Table Properties

Title: Attributes of Landclass OK Cancel

Creator:

Creation Date: Sunday, March 01, 1998 07:46:16

Comments

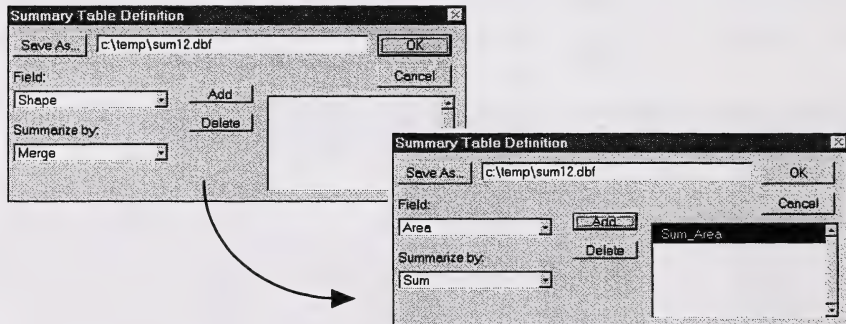
Visible	Field	Alias
☒	Area	
☐	Perimeter	
☒	Elc07	
☐	Elc07_id	
☒	Code	
☐	Elc_type	
☐	Elc_group	

Data Selection

Because attribute tables are linked to themes in a view, one can select records from tables and subsequently view feature locations by switching to the view window—selected features are highlighted in yellow.

Simple Analyses

The following example shows how to perform a simple summary of selected data fields. Click on the field *Description*, then select SUMMARIZE from the FIELD menu, or click on the summarise button . The *Summary Definition* window appears. Select the FIELD 'Area' and SUMMARISE by 'Sum'.



Summary Table Definition

Save As... c:\temp\sum12.dbf OK Cancel

Field: Shape Add

Summarize by: Merge Delete

Summary Table Definition

Save As... c:\temp\sum12.dbf OK Cancel

Field: Area Add

Summarize by: Sum Delete

Sum_Area

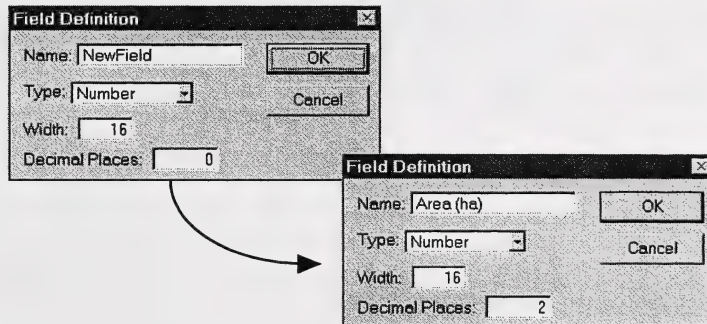
ADD the field summary then click OK. ArcView quickly performs the summary and presents the data in a new table on-screen. If a directory or filename is not specified, ArcView saves the new table to the *Temp* directory on you local drive.

sum12.dbf		
<i>Description</i>	<i>Count</i>	<i>Sum_Area</i>
CLOSED ASPEN, B. POPLAR AND/OR BIRCH	530	239879639.7891
CLOSED BLACK SPRUCE	8	237500.0000
CLOSED CONIFEROUS DOMINATED MIXED WOOD	585	55837832.5703
CLOSED DECIDUOUS DOMINATED MIXED WOOD	212	12074277.1094
CLOSED WHITE SPRUCE	472	97527177.7344
EMERGENT WETLANDS (CATTAILS)	6	206250.0000
GRAMINOID CLEARCUT	3	408362.5000
GRAMINOID WETLANDS (SEDGES/GRASSES)	180	69559165.9297
MAJOR HYDROGRAPHY	51	13628120.5625
OPEN BLACK SPRUCE BOG (SPHAGNUM UNDER.)	419	103179849.9844
OPEN SPHAGNUM BOG	59	3062858.9297
SHRUBBY WETLANDS (WILLOW/BIRCH FENS)	530	201633032.0234
TREE/SHRUB DOMINANT CLEARCUT	43	5153750.0000

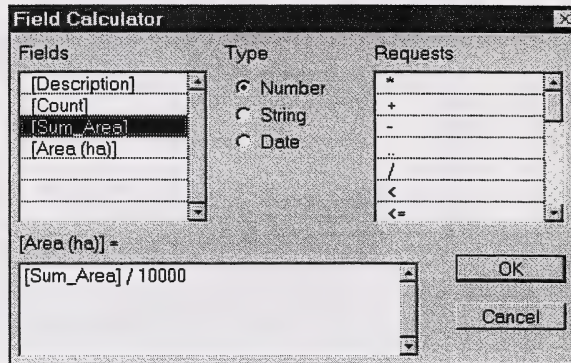
Editing Tables

In this data set, theme units have been set to metres, and all summaries of area and distance are reported in the same units. This may not be convenient in some instances, so the table can be edited to show units suited to the area, length, or height of features. To begin editing a table, select **START EDITING** from the **TABLE** menu. The table is in edit mode when the field names are not written in *italics*. The following example shows how to add an additional field and calculate new values for the field.

To add a field select **ADD FIELD** from the **EDIT** menu. The *Field Definition* window appears. Next, define the attributes for the field. Click **OK** and a field will be created and added to the table.



To calculate feature area in hectares, select **CALCULATE** from the **FIELD** menu, or click the calculate button . The *Field Calculator* window appears. Enter the formula needed to calculate the values for the new field. To calculate area in hectares, divide the *Sum_Area* field by 10 000 (1ha=10 000m²). This formula is entered by a combination of selecting items from the menu and typing-in additional values.



Click OK and values based on this calculation will appear in the new field of the summary table.

sum12.dbf			
Description	Count	Sum Area	Area (ha)
CLOSED ASPEN, B. POPLAR AND/OR BIRCH	530	239879639.7891	23987.96
CLOSED BLACK SPRUCE	8	237500.0000	23.75
CLOSED CONIFEROUS DOMINATED MIXED WOOD	585	55837832.5703	5583.78
CLOSED DECIDUOUS DOMINATED MIXED WOOD	212	12074277.1094	1207.43
CLOSED WHITE SPRUCE	472	97527177.7344	9752.72
EMERGENT WETLANDS (CATTAILS)	6	206250.0000	20.63
GRAMINOID CLEARCUT	3	408362.5000	40.84
GRAMINOID WETLANDS (SEDGES/GRASSES)	180	69559165.9297	6955.92
MAJOR HYDROGRAPHY	51	13628120.5625	1362.81
OPEN BLACK SPRUCE BOG (SPHAGNUM UNDER)	419	103179849.9844	10317.98
OPEN SPHAGNUM BOG	59	3062858.9297	306.29
SHRUBBY WETLANDS (WILLOW/BIRCH FENS)	530	201633032.0234	20163.30
TREE/SHRUB DOMINANT CLEARCUT	43	5153750.0000	515.38

You can stop and save edits to tables by selecting SAVE EDITS or STOP EDITING in the TABLE menu.

Tips and Tricks

Use the sort ascending  or descending  features to sort records and then hold the SHIFT key and select multiple records in the database. This procedure enables selection of specific records without using the query builder tool and these records will be highlighted in the view.

Working with Charts

ArcView can convert tabular data to charts and graphs, but its capabilities are limited. When available, it is recommended that a spreadsheet program (e.g., Microsoft Excel) be used with tabular data exported from ArcView to build a chart or graph.

Menus and Toolbar

Toolbar buttons which have been previously described do not appear in subsequent lists



UNDO LAST ERASE - Cancels the last erase made to the chart.



AREA CHART GALLERY - Shows the available options for area charts.



BAR CHART GALLERY - Shows the available options for bar charts.



COLUMN CHART GALLERY - Shows the available options for column charts.



LINE CHART GALLERY - Shows the available options for line charts.



PIE CHART GALLERY - Shows the available options for pie charts.



XY SCATTER CHART GALLERY - Shows the available options for XY scatter charts.



SERIES FROM RECORDS/FIELDS - Toggles plotting of chart data series from records or fields on a chart when your chart represents two or more data fields.



ERASE - Removes data markers from a chart and unselects records from the table.



ERASE WITH POLYGON - By drawing a polygon around markers, you can remove one or more data markers from an X,Y scatter chart.



CHART ELEMENT PROPERTIES - Sets the properties of the elements in the active chart.

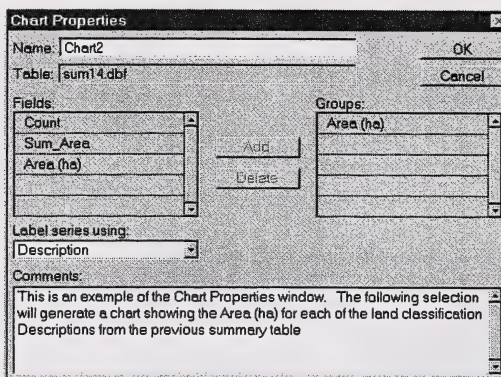


CHART COLOUR - Changes the colour

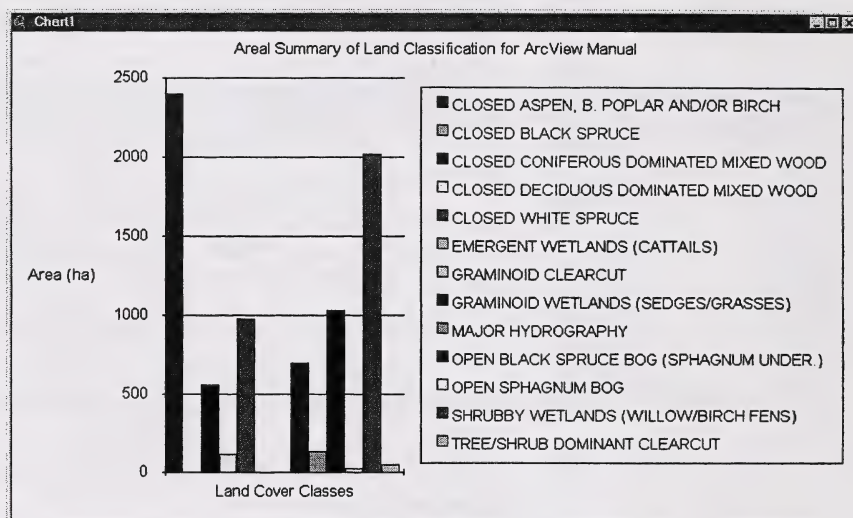
Adding Data

One should consider what data is to be converted to a chart or graph. Quite often ArcView cannot build a chart or graph due to a large number of records. Only summarised data should be considered when creating charts.

To initiate a chart, select NEW with the *Chart* icon highlighted in the project window. ArcView lets you select a table to use for a chart, unless there is only one table available, then ArcView selects it by default. The *Chart Properties* window appears and allows the user to enter the criteria that will generate the chart.



With some simple editing one can create a functional, although very plain looking, chart from a tabular data source.



Editing Chart Styles

ArcView permits the creation of a variety of chart styles including pie charts, bar charts, scatter charts, column charts, and area charts. Chart style selection will depend on the type of data being portrayed and the intent of the chart. Within ArcView, chart styles can be altered easily—simply select the icon representing the desired chart style.

Tips and Tricks

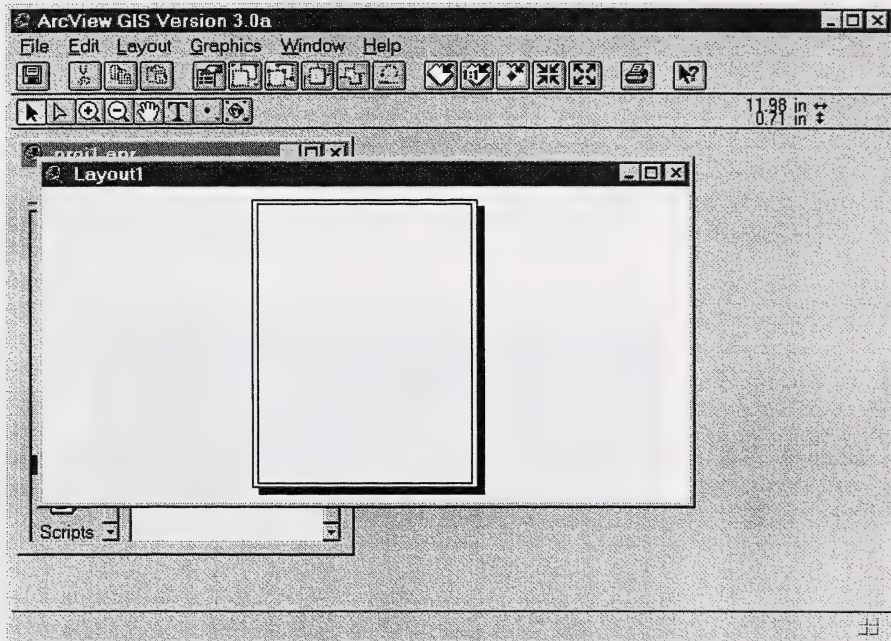
In ArcView, charting capabilities are highly automated but also limited. If you have access to a spreadsheet program (e.g., Microsoft Excel, Lotus 1-2-3), export your tabular data from ArcView to create presentable charts and graphs.

Working with Layouts

Once a view is customised, summary tables created, and charts built, the user can set up a layout in ArcView to show all these elements together.

Adding Data & Layout Properties

The layout is an integration point for other elements from the project. This allows map generation to occur relatively quickly. The first step in creating a map is to set up page size, margins, and snapping environments. All of these can be performed from the PROPERTIES and PAGE SETUP commands in the LAYOUT menu.



Menus and Toolbars

Toolbar buttons which have been previously described do not appear in subsequent lists



GROUP - Groups graphics together into a single graphic so you can manipulate them as one object.



UNGROUP - Ungroups graphics into separate objects.



BRING TO FRONT - Moves selected graphic to the front of the view.



SEND TO BACK - Sends the selected graphic to the back of the view.



ZOOM TO PAGE - Zooms selected area (in or out) to the layout page size.



ZOOM TO ACTUAL SIZE - Zooms selected area to the actual size of the layout.



PRINT - Prints the active layout.

Frame Tools



Adds a view frame to the layout



Adds a legend frame to the layout



Adds a scale bar frame to the layout



Adds a north arrow frame to the layout



Adds a chart frame to the layout



Adds a table frame to the layout



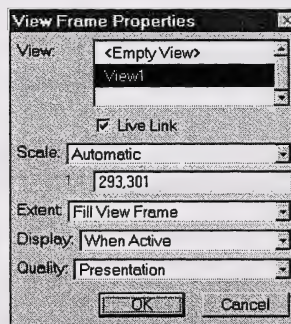
Adds a picture frame to the layout

View Frame Properties

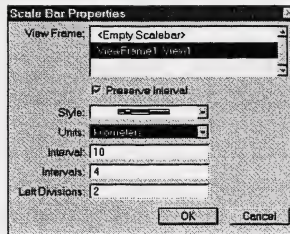
Frame tools are used to add components to a layout. To add a frame component, click on one of the frame tools, drag an area across the page using the mouse. This area defines the new frame element, size, and page position. Some frame elements are dependent on other elements appearing in the layout. For example, a scale bar frame can not be added unless there is a view frame active in the layout. Also, a chart or table frame will not show any data unless the windows from their respective sources are *open* in the project.

Once a frame is established, ArcView will prompt the user for a component to be placed in the frame and, in some cases, options to customise the element.

When adding a view frame, ArcView prompts for specific information regarding how the view will be displayed.

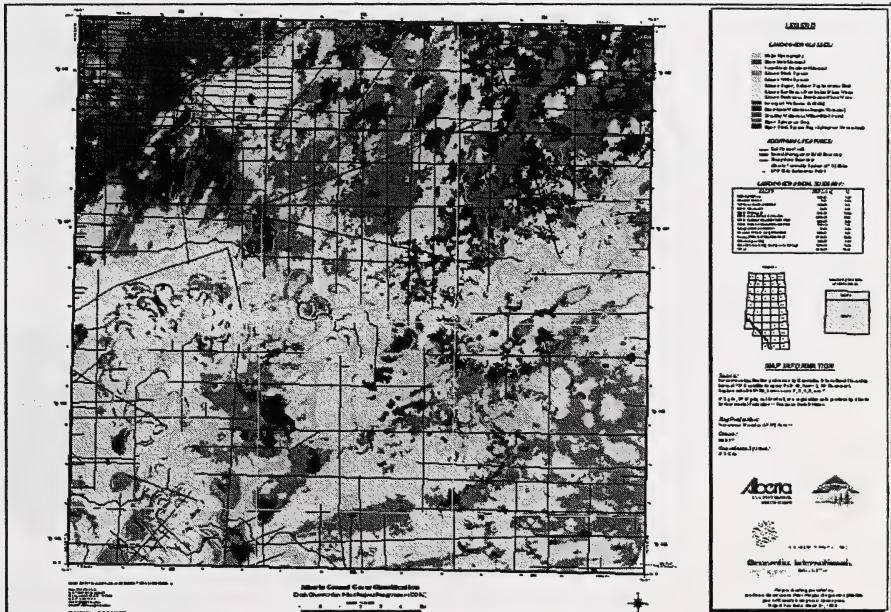


In the *View Frame Properties Window* a user can specify the view to displayed, the scale for display, and whether it is actively linked to the view window. Once the view frame is established in the layout, a scale bar can be added. The *Scale Bar Frame Properties* window prompts the user for information including which view frame it corresponds to, the style of scale bar, and the units and intervals to use.



Adding Cartographic Elements

With the addition of cartographic elements such as north arrows, legends, titles, map information, and additional graphics (e.g., scanned images), a professional product can be created in less than a day.



Importing Graphics

Graphic files can be inserted into layouts using the PICTURE FRAME  tool. Supported image formats include: .BIL, .BIP, .BSP, .GIF, .EPS, .GIS, .LAN, .RLC,

.MCP, .NBI, .PS, .TIF, .BMP, .WMF, .XBM, and .RS. This command is particularly useful for inserting photos, logos, and lineart.

Tips and Tricks

All theme legends in the table of contents must show for their respective symbol to appear in the *Legend* frame.

Frame elements, including the view frame, can be *simplified* into graphics and subsequently edited via the symbol window. To simplify an element, highlight it then select SIMPLIFY from the GRAPHICS menu.

One of the key aspects of a professional looking product is the alignment and spacing of map elements relative to one another. Use the *Align* window (select ALIGN from the GRAPHICS menu) to adjust the position and spacing of elements in the layout.

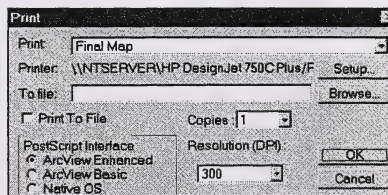
Printing and Exporting

Although printing and exporting in ArcView is relatively simple, it can become difficult due to external factors such as:

- types of printers (postscript capability);
- import/export filters of other software programs; and,
- operating system ArcView runs on (e.g., Win95 or WinNT).

Printing

One can print within all components of an ArcView project. Selecting PRINT opens the *print window* and displays the default printer on the system.



If the printer has Postscript capabilities, the following three options will appear:

ArcView Enhanced This option sends the print using *Postscript Level II*. If the printer is not Level II compliant output will be muddled;

ArcView Basic This option sends the print as a *Postscript Level I*; and,

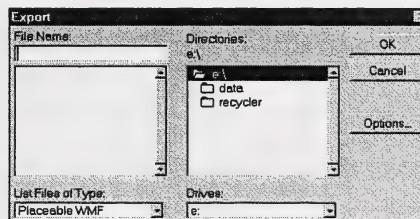
Native OS This option sends the print based on the operating system language of the selected printer.

If the printer does not support Postscript, then a standard print window appears.

Exporting

With ArcView, views and layouts can be exported to various file formats. ESRI has tested importing these graphics files into a variety of applications, however, you may encounter an application that cannot read one of these files. For example, Adobe Illustrator cannot read EPS files created with ArcView, whereas CorelDraw can. Microsoft PowerPoint sometimes cannot read ArcView's .WMF format correctly, whereas Microsoft Word can.

To export a view or layout select EXPORT from the FILE menu. The *export window* allows one to type in the file name and path where it will be saved, and select the type of graphic file.



ArcView can export to the following formats:

- .WMF Windows Metafile;
- .BMP Windows Bitmap;
- .EPS Postscript level I or II (new);
- .AI Adobe Illustrator; and,
- .CGM Computer Graphics Metafile.

Advanced Features

There are several features offered in ArcView that can make subsequent projects easier to complete. As you continue learning ArcView you will develop your own work arounds that increase efficiency. To search for help on information beyond this manual the use of ArcView's Online Help is recommended.

Copying Layouts

If you wish to apply an existing layout to a new one, you can simply select all features, copy, and paste them into the new layout. Some features will "jump" to the foreground and will have to be sent to the back again.

Templates

If you consistently use the identical layout for all maps it is useful to generate a template based on it. To create a template select STORE AS TEMPLATE from the LAYOUT menu. You can specify a name for the template, then use it any time you start a new layout. Sometimes, the file used to store ArcView templates is reset to default and any templates added by the user "disappear". For this reason, the copy and paste approach between layouts is recommended.

Rotating Maps

When large scale maps (e.g., 1:50 000) are displayed in a 2-D environment, some projections result in map rotation that deviates from 90° (i.e., straight up-and-down). If a map with its major boundaries parallel to neatlines is desired, one can SIMPLIFY the view frame into a graphic, group all the elements, then store as a north arrow. The north arrow "map" can be added to the layout, specifying a rotation angle compensating for the previous map angle. Issues associated with scale make this process best left for the more advanced user.

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Appendix 1: Alberta Classification Scheme

Alberta EOP3 Land Cover Classification Scheme
March 20, 1998

A. ANTHROPOGENIC

1. Urban and Industrial

- 11. (URB) Urban (cities, towns- mostly residential and downtown core areas)
- 12. (COM) Commercial and/or industrial (industrial parks, heavy oil sand development, refineries, wellsites, hydro generating facilities)
- 13. (MRD) Major road, highway, and/or railway
- 14. (PIP) Pipeline and/or power line right-of-way (corridors)
- 15. (SUR) Surface mine (coal), gravel pit, and /or spoil pile
- 16. (FAR) Farmstead and/or ranch (including shelter belts)

2. Agricultural

- 21. (ACR) Cropland
- 22. (AIR) Irrigated land
- 23. (ACL) Agricultural clearing (recently cleared land, often with windrows)

3. Clearcuts

- 31. (CGR) Graminoid (grass and sedge) dominated clearcut
- 32. (CTS) Tree and shrub dominated clearcut
- 33. (CTR) Tree (replanted - immature trees, <20 years) dominated clearcut

4. Burns

- 41. (BG) Graminoid (grass and sedge) dominated burn
- 42. (BTS) Tree and shrub dominated burn
- 43. (BT) Tree dominated burn

B. UPLANDS

5. Forested Lands (>6% Tree Cover)

Coniferous Dominated Forest (>80% coniferous cover based on occurrence)

Closed (>40% crown closure)

Open (6-40% crown closure)

51. (BSC) Closed black spruce

151. (BSO) Open black spruce

52. (PC) Closed pine

152. (PO) Open pine

53. (WSC) Closed white spruce

153. (WSO) Open white spruce

54. (CUC) Closed undifferentiated
coniferous

154. (UCO) Open undifferentiated coniferous

Deciduous Dominated Forest (>80% deciduous cover based on occurrence)

Closed (>40% crown closure)

Open (6-40% crown closure)

55. (DC) Closed aspen, balsam poplar and/or
birch

155. (DO) Open aspen, balsam poplar and/or
birch

05. (RIP) Riparian poplar

Mixed Wood Dominated Forest (>20-80% mixed wood cover based on occurrence)

Closed (>40% crown closure)

Open (6-40% crown closure)

56. (MCC) Closed coniferous dominated
mixedwood (60-80% coniferous cover)

156. (MCO) Open coniferous dominated
mixedwood (60-80% coniferous cover)

57. (MDC) Closed deciduous dominated
mixedwood (60-80% deciduous cover)

157. (MDO) Open deciduous dominated
mixedwood (60-80% deciduous cover)

58. (MCDC) Closed coniferous and
deciduous mixedwood (20-60%)

158. (MCDO) Open coniferous and deciduous
mixedwood (20-60%)

6. Shrublands (>25% shrub cover and <6% tree cover)

Closed shrublands (streams and coolies)

61. (RSC) Closed riparian shrub

62. (CSC) Closed coulee shrub thicket

63. (USC) Closed upland shrub

Open shrublands

161. (RSO) Open riparian shrub

162. (CSO) Open coulee shrub thicket (i.e. chokecherry/buffaloberry, rose,
buckbrush, saskatoon)

163. (USO) Open upland shrub

164. (SO) Open sagebrush flat

7. Grasslands (<25% shrub cover and <6% tree cover) and Upland Forbs (<6% graminoid)

Graminoids (grasses and sedges)

- 71. (GF) Fescue grassland
- 72. (GM) Mixed grassland
- 73. (GS) Sandhill grassland
- 74. (GC) Coulee grassland (grassland on steep coulee slopes)

Upland Forbs

- 75. (UFM) Upland forb meadow

C. WETLANDS AND WATER

8. Wetlands

- 81. (WE) Emergent wetland (cattails)
- 82. (WG) Graminoid wetland (sedges and grasses and forbs)
- 83. (WS) Shrubby wetland (willow and birch fens in the north; willow swamps on the prairie)
- 84. (WSB) Sphagnum bog
- 85. (WOL) Lichen bog
- 86. (WBS) Black spruce bog (Sphagnum understory)
- 87. (WBL) Black spruce bog (lichen understory)

9. Water

- 91. (WTR) Lake, pond, reservoir, river and/or stream

D. BARREN LANDS

10. Barren (<6% Vegetation Cover)

- 101. (BPI) Permanent ice and/or snow
- 102. (BR) Rock, talus and/or avalanche chute
- 103. (BS) Exposed soil
- 104. (BAF) Alkali flat and/or mud flat
- 105. (BUD) Upland dune field
- 106. (BAD) Alluvial deposit
- 107. (BB) Beach
- 108. (BBL) Badland
- 109. (BBZ) Blowout zone

E. UNCLASSIFIED (Due to cloud cover, haze or shadow)

- 111. (UC) Cloud
- 112. (UH) Haze
- 113. (US) Shadow

Appendix 2: F.B.P. Fuel Type Classification Scheme

F.B.P FUEL TYPE CLASSIFICATION SCHEME

1. Coniferous

- C-1. Spruce-Lichen Woodland
- C-2. Boreal Spruce
- C-3. Mature Jack or Lodgepole Pine
- C-4. Immature Jack or Lodgepole Pine
- C-5. Red and White Pine
- C-6. Conifer Plantation
- C-7. Ponderosa Pine/Douglas-fir

2. Deciduous

- D-1. Leafless Aspen

3. Mixedwood

- M-1. Boreal Mixedwood—Leafless
- M-2. Boreal Mixedwood—Green
- M-3. Dead Balsam Fir/Mixedwood—Leafless
- M-3. Dead Balsam Fir/Mixedwood—Green

4. Slash

- S-1. Jack or Lodgepole Pine Slash
- S-2. Spruce/Balsam Slash
- S-3. Coastal Cedar/Hemlock/Douglas-fir Slash

5. Open

- O-1a. Matted Grass
- O-1b. Standing Grass

Appendix 3: ArcView Toolbar Buttons

TOOLBAR BUTTONS OF THE VIEW WINDOW



SAVE - Saves the current project.



ADD THEME - Allows you to add one or more themes to the view.



THEME PROPERTIES - Lets you change the properties of the theme.



EDIT LEGEND - Lets you change how the active theme is displayed.



OPEN THEME TABLE - Opens the attribute table for the active theme(s) in the view.



FIND - Finds a feature in a view, table, or chart that has the value you type in.



LOCATE ADDRESS - Locates a specific address in the active theme(s)



QUERY BUILDER - Queries data according to attributes via a query expression



ZOOM TO FULL EXTENT - Zooms to full extent of all themes.



ZOOM TO ACTIVE THEME(S) - Zooms to the extent of the features in the active theme(s).



ZOOM TO SELECTED - Zooms to the extent of the currently selected features in the active theme(s).



ZOOM IN - Zooms in by a factor of 2.



ZOOM OUT - Zooms out by a factor of 2.



ZOOM TO PREVIOUS EXTENT - Goes back to the previous extent you were viewing.



SELECT FEATURES USING GRAPHIC - Selects features from the active theme(s) located under the currently selected graphic(s) drawn on the view.



CLEAR SELECTED FEATURES - Deselects selected features in the active theme(s).



HELP - Click on this, then select the button, tool, or menu choice you want help about.



IDENTIFY TOOL - Displays the attribute values of a feature shown in a view, table, or chart.



POINTER TOOL - Selects, moves, and resizes graphics.



VERTEX EDIT TOOL - Reshapes a feature or graphic by moving, adding, or deleting vertices.



SELECT FEATURES TOOL - Selects features from the active theme(s) in the view.



ZOOM IN TOOL - Zooms in based on a position or area defined with the mouse



ZOOM OUT TOOL - Zooms out based on a position or area defined with the mouse.



PAN TOOL - Pans across the view by dragging the display with the mouse.



MEASURE TOOL - Measures distances on a view.



HOT LINK TOOL - Follows a hot link by clicking on a feature in the active theme.



AREA OF INTEREST TOOL - Sets the area of interest for a view containing library-based themes.



LABEL TOOL - Labels a feature in the active theme.



TEXT TOOL - Adds or edits text in a view

Drawing and Editing Tools



Draw a point



Draw a straight line



Draw a line with two or more vertices



Draw a rectangle



Draw a circle



Draw a polygon



Draw a line to split line features



Draw a line to split polygon features



Draw a line to append a new polygon adjacent to other polygons

TOOLBAR BUTTONS OF THE TABLE WINDOW



SAVE - Saves the current project.



CUT - Cuts the data from the active cell



COPY - Copies data in the active cell.



PASTE - Pastes the selection you cut or copy.



SELECT ALL - Highlights all records within the table.



SELECT NONE - Clears the current selection in a table.



SWITCH SELECTION - Switches selected and unselected records in the table.



CREATE CHART - Creates a chart from data in the active table.



FIND - Finds a record of interest in the active table.



QUERY BUILDER - Queries data according to attributes via a query expression.



PROMOTE - Brings all selected records together at the top of the active table.



JOIN - Joins another table to the active table, using the values of a common field in both tables.



SUMMARISE - Summarises the active table, using the active field. A new table is created for this new data.



CALCULATE - Calculates the values in the active field using the expression you want.



SORT ASCENDING - Sorts records in the active field, beginning with the lowest number, first letter of the alphabet, or the earliest date.



SORT DECENDING - Sorts records in the active field, beginning with the highest

number, the last letter of the alphabet, or the latest date.



HELP - Click on this, then select the button, tool, or menu choice you want help about.



POINTER TOOL - Selects, moves, and resizes elements and/or records in the table.



EDIT - Edits the records in a table.



IDENTIFY TOOL - Displays the attribute values of a feature shown in the table.

TOOLBAR BUTTONS OF THE CHARTS WINDOW



SAVE - Saves the current project



UNDO LAST ERASE - Cancels the last erase made to the chart.



AREA CHART GALLERY - Shows the available options for area charts.



BAR CHART GALLERY - Shows the available options for bar charts.



COLUMN CHART GALLERY - Shows the available options for column charts.



LINE CHART GALLERY - Shows the available options for line charts.



PIE CHART GALLERY - Shows the available options for pie charts.



XY SCATTER CHART GALLERY - Shows the available options for XY scatter charts.



CHART PROPERTIES - Lets you change the properties of the chart.



SERIES FROM RECORDS/FIELDS - Toggles plotting of chart data series from records or fields on a chart when your chart represents two or more data fields.



FIND - Finds a record of interest in the active table.



HELP - Click on this, then select the button, tool, or menu choice you want help about.



ERASE - Removes data markers from a chart and unselects records from the table.



ERASE WITH POLYGON - By drawing a polygon around markers, you can remove one or more data markers from an XY scatter chart.



CHART ELEMENT PROPERTIES - Sets the properties of the elements in the active chart.



CHART COLOUR - Changes the colour of chart elements.

TOOLBAR BUTTONS OF THE LAYOUT WINDOW



SAVE - Saves the current layout.



CUT - Cuts the selection from a layout.



COPY - Copies the selection from a layout.



PASTE - Pastes the selection you cut or copy.



LAYOUT PROPERTIES - Lets you change the properties of the layout.



GROUP - Groups graphics together into a single graphic so you can manipulate them as one object.



UNGROUP - Ungroups graphics into separate objects.



BRING TO FRONT - Moves selected graphic to the front of the view.



SEND TO BACK - Sends the selected graphic to the back of the view.



UNDO - Cancels the last edit completed to the layout.



ZOOM TO PAGE - Zooms selected area (in or out) to the layout page size.



ZOOM TO ACTUAL SIZE - Zooms selected area to the actual size of the layout.



ZOOM TO SELECTED - Zooms to the extent of the currently selected features in the active theme(s).



ZOOM IN - Zooms in by a factor of 2.



ZOOM OUT - Zooms out by a factor of 2.



PRINT - Prints the active layout.



HELP - Click on this, then select the button, tool, or menu choice you want help about.



POINTER TOOL - Selects, moves, and resizes graphics.



VERTEX EDIT TOOL - Reshapes a feature or graphic by moving, adding, or deleting vertices.



ZOOM IN TOOL - Zooms in based on a position or area defined with the mouse



ZOOM OUT TOOL - Zooms out based on a position or area defined with the mouse.



PAN TOOL - Pans across the view by dragging the display with the mouse.



TEXT TOOL - Adds or edits text in a view

DRAWING AND EDITING TOOLS



Draw a point.



Draw a straight line



Draw a line with two or more vertices



Draw a rectangle



Draw a circle



Draw a polygon

FRAME TOOLS



Adds a view frame to the layout



Adds a legend frame to the layout



Adds a scale bar frame to the layout



Adds a north arrow frame to the layout



Adds a chart frame to the layout



Adds a table frame to the layout



Adds a picture frame to the layout

Appendix 4: Workshop Data Summary

March 3-4, 1998

DATA SETS FOR EOP3 ARCVIEW COURSE WORKSHOP WORKSPACE

/WORKSHOP/PRAIR

BOUNDRY1	Boundary Arc Coverage (poly) - utm zone 12, nad27
HYDRO_L1	Hydrology Arc Coverage (line) - utm zone 12, nad27
LANDCLS1	Classified Arc Coverage (poly) - utm zone 12, nad27
LANDCLS1.E00	Classified Arc Coverage export format- utm zone 12, nad27
LANDCLS2	Classified Arc Coverage (poly) - decimal degrees
PASITES1	Protected Areas Arc Coverage - utm zone 12, nad27
ROADS1	Roads Arc Coverage (line) - utm zone 12, nad27
TWPRNG1	ATS grid in Arc Coverage (poly) - utm zone 12, nad27
UTMTICS1	UTM Tic Locations in Arc Coverage (point) - utm zone 12, nad27

/WORKSHOP/SESLOPE

BOUNDRY1	Boundary Arc Coverage (poly) - utm zone 11, nad27
HYDRO_L1	Hydrology Arc Coverage (line) - utm zone 11, nad27
LANDCLS1	Classified Arc Coverage (poly) - utm zone 11, nad27
PASITES1	Protected Areas Arc Coverage - utm zone 11, nad27
ROADS1	Roads Arc Coverage (line) - utm zone 11, nad27
ROADS1.DXF	Roads DXF file - utm zone 11, nad27
TRAILS1	Seismic lines Arc Coverage (line) - utm zone 11, nad27
TWPRNG1	ATS grid in Arc Coverage (poly) - utm zone 11, nad27
UTM_TICS	UTM Tic Locations in Shape File (point) - utm zone 11, nad27

/WORKSHOP/NWBOREAL

BOUNDRY1	Boundary Arc Coverage (poly) - utm zone 11, nad27
FMU1	FMU boundaries Arc Coverage (line) - utm zone 11, nad27
HYDRO_L1	Hydrology Arc Coverage (line) - utm zone 11, nad27
IMAGE.TIF	Image of classified Arc Coverage (associated with header file image.tfw)
LANDCLS1	Classified Arc Coverage (poly) - utm zone 11, nad27
TRAILS1	Seismic lines Arc Coverage (line) - utm zone 11, nad27
TWPRNG1	ATS grid in Arc Coverage (poly) - utm zone 11, nad27
UTM_TICS	UTM Tic Locations in Shape File (point) - utm zone 11, nad27

/WORKSHOP/IMAGES/INSETS

ABBOUND	Alberta provincial boundary in Shape File (poly) - 10° transverse mercator, nad27
GRID250	Alberta 1: 250 000 NTS map network in Shape File (poly) - 10° transverse mercator, nad27

/WORKSHOP/IMAGES/LOGOS

AEP_LOGO.GIF	Alberta Environmental Protection logo
GAIA_LOGO.WMF	GAIA Consultants Inc. logo
GEO_LOGO.GIF	Geomatics International Inc. Logo

/WORKSHOP/IMAGES/SCANNING

NWBOREAL.TIF	Digital image of NW boreal region used for ground truthing
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Appendix 5: CCOGIF Feature Codes

CCOGIF Feature Codes (3/26/98)

TYPE	CCOGIF	DESCRIPTION	CLASS	LEVEL	WEIGHT	STYLE	COLOUR	FONT
17	KZ42450000	MAP NAME	15	1	1	0	1	42
3	KA04850000	BORDER-GEOGRAPHIC	72	1	0	0	1	
3	KA04900000	BORDER-GEOGRAPHIC TICKS	72	1	0	0	2	
3	KA48100000	NEAT LINE	72	1	3	0	1	
4	KA04850000	BORDER-GEOGRAPHIC	72	1	0	0	1	
4	KA04900000	BORDER-GEOGRAPHIC TICKS	72	1	0	0	2	
4	KA48100000	NEAT LINE	72	1	3	0	1	
17	KA30600000	BORDER-GEOGRAPHIC TEXT	72	1	0	0	2	66
3	AR65700000	SETTLEMENT	58	2	0	0	2	
3	AR65700200	SETTLEMENT	58	2	0	0	99	
3	AR75750000	TOWNSHIP/RANGE-SURVEYED	15	2	0	0	3	
3	AR75750200	TOWNSHIP/RANGE-SURVEYED	15	2	0	0	99	
3	AR75800000	TWP/RANGE-UNSURVEYED	15	2	0	3	4	
3	AR75800200	TWP/RANGE-UNSURVEYED	15	2	0	3	99	
4	AR65700000	SETTLEMENT	58	2	0	0	2	
4	AR65700200	SETTLEMENT	58	2	0	0	99	
4	AR75750000	TOWNSHIP/RANGE-SURVEYED	15	2	0	0	3	
4	AR75750200	TOWNSHIP/RANGE-SURVEYED	15	2	0	0	99	
4	AR75800000	TWP/RANGE-UNSURVEYED	15	2	0	3	4	
4	AR75800200	TWP/RANGE-UNSURVEYED	15	2	0	3	99	
17	AR65700000	SETTLEMENT	58	2	0	0	2	66
17	AR75700000	TOWNSHIP/RANGE	15	2	0	0	3	66
17	AR75720000	TOWNSHIP/RANGE	15	2	0	0	99	66
3	AR65300000	SECTION-SURVEYED	15	3	0	0	7	
3	AR65300200	SECTION-SURVEYED	15	3	1	0	99	
3	AR65350000	SECTION-UNSURVEYED	15	3	0	5	8	
3	AR65350200	SECTION-UNSURVEYED	15	3	0	5	99	
3	FA40600000	LINE-SURVEYED	15	3	0	0	17	
3	FA40600200	LINE-SURVEYED	15	3	0	0	99	
4	AR65300000	SECTION-SURVEYED	15	3	0	0	7	
4	AR65300200	SECTION-SURVEYED	15	3	1	0	99	
4	AR65350000	SECTION-UNSURVEYED	15	3	0	5	8	
4	AR65350200	SECTION-UNSURVEYED	15	3	0	5	99	
4	FA40600000	LINE-SURVEYED	15	3	0	0	17	
4	FA40600200	LINE-SURVEYED	15	3	0	0	99	
17	AR65300000	SECTION-SURVEYED	15	3	0	0	7	66
17	AR65350000	SECTION-UNSURVEYED	15	3	0	0	8	66
17	AR65300200	SECTION-SURVEYED	15	3	0	0	99	66
17	AR65350200	SECTION-UNSURVEYED	15	3	0	0	99	66
3	AR56400000	QUARTER SECT-SURVEYED	15	4	0	0	9	
3	AR56400200	QUARTER SECT-SURVEYED	15	4	0	0	99	
3	AR56450000	QUARTER SECT-UNSURVEYED	15	4	0	3	10	
3	AR56450200	QUARTER SECT-UNSURVEYED	15	4	0	3	99	
4	AR56400000	QUARTER SECT-SURVEYED	15	4	0	0	9	
4	AR56400200	QUARTER SECT-SURVEYED	15	4	0	0	99	
4	AR56450000	QUARTER SECT-UNSURVEYED	15	4	0	3	10	
4	AR56450200	QUARTER SECT-UNSURVEYED	15	4	0	3	99	
17	AR65300010	SECTION-SURVEYED	15	5	1	0	7	66
17	AR65350010	SECTION-UNSURVEYED	15	5	1	0	0	66

CCOGIF Feature Codes (3/26/98)

TYPE	CCOGIF	DESCRIPTION	CLASS	LEVEL	WEIGHT	STYLE	COLOUR	FONT
3	KA77050091	TRAN/MER-GR/TICK-UTM-Z11	72	6	0	0	4	
3	KA77100011	TRANSV/MERC-UTM-ZONE 11	72	6	0	0	1	
4	KA77050091	TRAN/MER-GR/TICK-UTM-Z11	72	6	0	0	4	
4	KA77100011	TRANSV/MERC-UTM-ZONE 11	72	6	0	0	1	
17	KA77100011	TRANSV/MERC-UTM-ZONE 11	72	6	0	0	1	66
3	KA77050092	TRAN/MER-GR/TICK-UTM-Z12	72	7	0	0	5	
3	KA77100012	TRANSV/MERC-UTM-ZONE 12	72	7	0	0	1	
4	KA77050092	TRAN/MER-GR/TICK-UTM-Z12	72	7	0	0	5	
4	KA77100012	TRANSV/MERC-UTM-ZONE 12	72	7	0	0	1	
17	KA77100012	TRANSV/MERC-UTM-ZONE 12	72	7	0	0	1	66
17	FB46850000	MONUMENT-INTERNATL BDY	47	9	0	0	3	120
17	FB46900000	MONUMENT-INTERPROV BDY	47	9	0	0	4	120
17	FC54350000	POINT-CONTROL-HORIZONTAL	48	10	0	0	13	120
17	FC54350001	POINT-CONTROL-HORIZONTAL	48	10	0	0	13	1
17	FC54600000	POINT-CONTROL-VERTICAL	48	10	0	0	14	120
17	FC54600001	POINT-CONTROL-VERTICAL	48	10	0	0	14	1
17	KB54200000	POINT-CHECK	48	10	0	0	15	120
17	KB54200001	POINT-CHECK	48	10	0	0	15	1
17	KB54450000	POINT-PASS	48	10	0	0	11	120
17	KB54450001	POINT-PASS	48	10	0	0	11	1
17	KB54550000	POINT-TIE	48	10	0	0	12	120
17	KB54550001	POINT-TIE	48	10	0	0	12	1
17	KB54550200	BLOCK TIE	48	10	0	0	16	120
17	KB54550201	BLOCK TIE	48	10	0	0	16	1
3	GB37950000	LAKE-PERENNIAL	51	11	0	0	48	
3	GB37950200	LAKE-PERENNIAL	51	11	0	0	99	
3	GB49850000	OXBOW-PERENNIAL	51	11	0	0	53	
3	GB49850200	OXBOW-PERENNIAL	51	11	0	0	99	
3	GE36250000	ISLAND-WITHIN LAKE	51	11	0	0	51	
3	GE36250200	ISLAND-WITHIN LAKE	51	11	0	0	99	
3	GE64150000	SAND BAR-WITHIN LAKE	51	11	0	6	63	
3	GE64150200	SAND BAR-WITHIN LAKE	51	11	0	6	99	
4	GB37950000	LAKE-PERENNIAL	51	11	0	0	48	
4	GB37950200	LAKE-PERENNIAL	51	11	0	0	99	
4	GB49850000	OXBOW-PERENNIAL	51	11	0	0	53	
4	GB49850200	OXBOW-PERENNIAL	51	11	0	0	99	
4	GE36250000	ISLAND-WITHIN LAKE	51	11	0	0	51	
4	GE36250200	ISLAND-WITHIN LAKE	51	11	0	0	99	
4	GE64150000	SAND BAR-WITHIN LAKE	51	11	0	6	63	
4	GE64150200	SAND BAR-WITHIN LAKE	51	11	0	6	99	
17	GB37950000	LAKE-PERENNIAL	66	11	1	0	48	67
17	GE36250000	ISLAND-WITHIN LAKE	51	11	1	0	51	67
3	GB37800000	LAKE-INTERMITTENT	51	12	0	3	49	
3	GB37800200	LAKE-INTERMITTENT	51	12	0	3	99	
3	GB49800000	OXBOW-INTERMITTENT	51	12	0	3	50	
3	GB49800200	OXBOW-INTERMITTENT	51	12	0	3	99	
3	GE36050000	ISLAND-INTERMITTENT	51	12	0	3	51	

CCOGIF Feature Codes (3/26/98)

TYPE	CCOGIF	DESCRIPTION	CLASS	LEVEL	WEIGHT	STYLE	COLOUR	FONT
3	GE36050200	ISLAND-INTERMITTENT	51	12	0	3	99	
4	GB37800000	LAKE-INTERMITTENT	51	12	0	3	49	
4	GB37800200	LAKE-INTERMITTENT	51	12	0	3	99	
4	GB49800000	OXBOW-INTERMITTENT	51	12	0	3	50	
4	GB49800200	OXBOW-INTERMITTENT	51	12	0	3	99	
4	GE36050000	ISLAND-INTERMITTENT	51	12	0	3	51	
4	GE36050200	ISLAND-INTERMITTENT	51	12	0	3	99	
17	GB37800000	LAKE-INTERMITTENT	66	12	1	0	49	67
17	GE36050000	ISLAND-INTERMITTENT	51	12	0	3	51	67
3	GB21400000	DUGOUT	51	13	0	0	55	
3	GB21400200	DUGOUT	51	13	0	0	99	
3	GB37500000	LAGOON-COMMERCIAL	51	13	0	0	54	
3	GB37500200	LAGOON-COMMERCIAL	51	13	0	0	99	
3	GB56300000	QUARRY-WATER FILLED	51	13	0	0	56	
3	GB56300200	QUARRY-WATER FILLED	51	13	0	0	99	
3	GB60300000	RESERVOIR	51	13	0	0	68	
3	GB60300200	RESERVOIR	51	13	0	0	99	
4	GB21400000	DUGOUT	51	13	0	0	55	
4	GB21400200	DUGOUT	51	13	0	0	99	
4	GB37500000	LAGOON-COMMERCIAL	51	13	0	0	54	
4	GB37500200	LAGOON-COMMERCIAL	51	13	0	0	99	
4	GB56300000	QUARRY-WATER FILLED	51	13	0	0	56	
4	GB56300200	QUARRY-WATER FILLED	51	13	0	0	99	
4	GB60300000	RESERVOIR	51	13	0	0	68	
4	GB60300200	RESERVOIR	51	13	0	0	99	
17	GB21400000	DUGOUT	66	13	0	0	55	66
17	GB37500000	LAGOON-COMMERCIAL	66	13	0	0	54	66
17	GB56300000	QUARRY-WATER FILLED	66	13	0	0	56	66
17	GB60300000	RESERVOIR	66	13	0	0	68	66
3	GA61850500	RIVER/STRM-MAJOR-L BANK	51	14	1	0	41	
3	GA61850700	RIVER/STRM-MAJOR-R BANK	51	14	1	0	42	
3	GE36300000	ISLAND-WITHIN RIVER	51	14	0	0	71	
3	GE64200000	SAND BAR-WITHIN RIVER	51	14	0	6	64	
4	GA61850500	RIVER/STRM-MAJOR-L BANK	51	14	1	0	41	
4	GA61850700	RIVER/STRM-MAJOR-R BANK	51	14	1	0	42	
4	GE36300000	ISLAND-WITHIN RIVER	51	14	0	0	71	
4	GE64200000	SAND BAR-WITHIN RIVER	51	14	0	6	64	
3	GA61850520	RIVER/STRM-MAJOR-L BANK	51	14	1	0	99	
3	GA61850720	RIVER/STRM-MAJOR-R BANK	51	14	1	0	99	
3	GE36300200	ISLAND-WITHIN RIVER	51	14	0	0	99	
3	GE64200200	SAND BAR-WITHIN RIVER	51	14	0	6	99	
4	GA61850520	RIVER/STRM-MAJOR-L BANK	51	14	1	0	99	
4	GA61850720	RIVER/STRM-MAJOR-R BANK	51	14	1	0	99	
4	GE36300200	ISLAND-WITHIN RIVER	51	14	0	0	99	
4	GE64200200	SAND BAR-WITHIN RIVER	51	14	0	6	99	
17	GA01900600	ARROW-FLOW-MAJOR RIVER	51	14	0	0	73	120
17	GA61850000	RIVER/STREAM-MAJOR	66	14	1	0	41	67
17	GE36300000	ISLAND-WITHIN RIVER	51	14	1	0	71	67
3	GA80100000	WETLAND	51	15	0	4	79	
4	GA80100000	WETLAND	51	15	0	4	79	

CCOGIF Feature Codes (3/26/98)

TYPE	CCOGIF	DESCRIPTION	CLASS LEVEL		WEIGHT	STYLE	COLOUR	FONT
3	GA80100200	WETLAND	51	15	0	4	99	
4	GA80100200	WETLAND	51	15	0	4	99	
3	GA61900000	RIVER/STREAM-PERENNIAL	51	16	0	0	44	
4	GA61900000	RIVER/STREAM-PERENNIAL	51	16	0	0	44	
3	GA61900200	RIVER/STREAM-PERENNIAL	51	16	0	0	99	
4	GA61900200	RIVER/STREAM-PERENNIAL	51	16	0	0	99	
17	GA01900800	ARROW-FLOW-RIVER/STREAM	51	16	0	0	74	120
17	GA61900000	RIVER/STREAM-PERENNIAL	66	16	1	0	44	67
3	GA61700000	RIVER/STREAM-INDEFINITE	51	17	0	5	47	
3	GA61750000	RIVER/STRM-INTERMITTENT	51	17	0	3	45	
4	GA61700000	RIVER/STREAM-INDEFINITE	51	17	0	5	47	
4	GA61750000	RIVER/STRM-INTERMITTENT	51	17	0	3	45	
3	GA61700200	RIVER/STREAM-INDEFINITE	51	17	0	5	99	
3	GA61750200	RIVER/STRM-INTERMITTENT	51	17	0	3	99	
4	GA61700200	RIVER/STREAM-INDEFINITE	51	17	0	5	99	
4	GA61750200	RIVER/STRM-INTERMITTENT	51	17	0	3	99	
17	GA61550000	RIVER/STRM-DISAPPEARING	51	17	0	0	46	120
17	GA61750000	RIVER/STRM-INTERMITTENT	66	17	1	0	45	67
3	AQ27700000	ROUTE-FERRY	51	18	0	3	52	
3	GA01350000	AQUEDUCT	55	18	0	7	61	
3	GA08800000	CANAL-IRRIGATION	51	18	0	0	57	
3	GA08850500	CANAL-MAJOR-LEFT BANK	51	18	0	0	59	
3	GA08850700	CANAL-MAJOR-RIGHT BANK	51	18	0	0	58	
3	GA20700000	DITCH-IRRIGATION	51	18	0	3	60	
3	GA28500000	FORD-WINTER CROSSING	55	18	0	3	65	
4	AQ27700000	ROUTE-FERRY	51	18	0	3	52	
4	GA01350000	AQUEDUCT	55	18	0	7	61	
4	GA08800000	CANAL-IRRIGATION	51	18	0	0	57	
4	GA08850500	CANAL-MAJOR-LEFT BANK	51	18	0	0	59	
4	GA08850700	CANAL-MAJOR-RIGHT BANK	51	18	0	0	58	
4	GA20700000	DITCH-IRRIGATION	51	18	0	3	60	
4	GA28500000	FORD-WINTER CROSSING	55	18	0	3	99	
3	AQ27700200	ROUTE-FERRY	51	18	0	3	99	
3	GA01350200	AQUEDUCT	55	18	0	7	99	
3	GA08800200	CANAL-IRRIGATION	51	18	0	0	99	
3	GA08850520	CANAL-MAJOR-LEFT BANK	51	18	0	0	99	
3	GA08850720	CANAL-MAJOR-RIGHT BANK	51	18	0	0	99	
3	GA20700200	DITCH-IRRIGATION	51	18	0	3	99	
3	GA28500200	FORD-WINTER CROSSING	55	18	0	3	99	
4	AQ27700200	ROUTE-FERRY	51	18	0	3	99	
4	GA01350200	AQUEDUCT	55	18	0	7	99	
4	GA08800200	CANAL-IRRIGATION	51	18	0	0	99	
4	GA08850520	CANAL-MAJOR-LEFT BANK	51	18	0	0	99	
4	GA08850720	CANAL-MAJOR-RIGHT BANK	51	18	0	0	99	
4	GA20700200	DITCH-IRRIGATION	51	18	0	3	99	
4	GA28500200	FORD-WINTER CROSSING	55	18	0	3	99	
17	AQ27700000	FERRY ROUTE	66	18	0	0	52	66
17	GA01350000	AQUEDUCT	66	18	0	0	61	66
17	GA01900500	ARROW-FLOW-MAJOR CANAL	51	18	0	0	75	120
17	GA08800000	CANAL-IRRIGATION	66	18	1	0	57	66

CCOGIF Feature Codes (3/26/98)

TYPE	CCOGIF	DESCRIPTION	CLASS	LEVEL	WEIGHT	STYLE	COLOUR	FONT
17	GA08850000	CANAL-MAJOR	66	18	1	0	59	66
17	GA20700000	DITCH-IRRIGATION	66	18	0	0	60	66
17	GA28500000	FORD-WINTER CROSSING	66	18	0	0	65	66
17	HA79250000	WATER LEVEL	55	19	0	0	72	67
3	GA19900000	DAM-MAJOR	55	20	0	0	77	
3	GA20000000	DAM-MINOR	55	20	0	0	66	
3	GA68650000	SPILLWAY	55	20	0	3	78	
4	GA19900000	DAM-MAJOR	55	20	0	0	77	
4	GA20000000	DAM-MINOR	55	20	0	0	66	
4	GA68650000	SPILLWAY	55	20	0	3	78	
17	EA79200000	WATER CONTROL DEVICE	55	20	0	0	67	120
17	EA79200001	WATER CONTROL DEVICE	55	20	0	0	67	66
17	GA19900000	DAM-MAJOR	66	20	1	0	77	66
17	GA20000000	DAM-MINOR	55	20	0	0	66	120
17	GA26450000	NAMED FALLS	51	20	0	0	70	120
17	GA26450001	NAMED FALLS	51	20	0	0	70	67
17	GA58300000	RAPIDS-LARGE	51	20	0	0	43	120
17	GA58300001	RAPIDS-LARGE	66	20	0	0	43	67
17	GA58350000	RAPIDS-MEDIUM	51	20	0	0	40	120
17	GA58350001	RAPIDS-MEDIUM	66	20	0	0	40	67
17	GA58450000	RAPIDS-SMALL	51	20	0	0	62	120
17	GA58450001	RAPIDS-SMALL	66	20	0	0	62	67
17	GA68650000	SPILLWAY	66	20	0	0	78	66
3	GD34700000	ICEFIELD	54	21	0	2	69	
4	GD34700000	ICEFIELD	54	21	0	2	69	
17	GD34700000	ICEFIELD	66	21	1	0	69	67
3	HA16150000	CONTOUR-INDEX	58	23	2	0	81	
3	HA16150300	CONTOUR-INDEX-DEPRESSION	58	23	2	1	85	
4	HA16150000	CONTOUR-INDEX	58	23	2	0	81	
4	HA16150300	CONTOUR-INDEX-DEPRESSION	58	23	2	1	85	
3	HA16150400	CONTOUR-INDEX	58	23	2	0	99	
3	HA16150330	CONTOUR-INDEX-DEPRESSION	58	23	2	1	99	
4	HA16150400	CONTOUR-INDEX	58	23	2	0	99	
4	HA16150330	CONTOUR-INDEX-DEPRESSION	58	23	2	1	99	
17	HA16150000	CONTOUR-INDEX	67	23	0	0	81	67
17	HA16150300	CONTOUR-INDEX-DEPRESSION	67	23	0	0	85	67
17	HA68950000	SPOT HEIGHT SYMBOL	58	23	0	0	91	120
17	HA68950001	SPOT HEIGHT TEXT	58	23	0	0	91	67
3	HA16200000	CONTOUR-INTERMEDIATE	58	24	0	0	82	
3	HA16200300	CONTOUR-INTERMEDIATE-DEP	58	24	0	1	87	
4	HA16200000	CONTOUR-INTERMEDIATE	58	24	0	0	82	
4	HA16200300	CONTOUR-INTERMEDIATE-DEP	58	24	0	1	87	
3	HA16200400	CONTOUR-INTERMEDIATE	58	24	0	0	99	
3	HA16200330	CONTOUR-INTERMEDIATE-DEP	58	24	0	1	99	
4	HA16200400	CONTOUR-INTERMEDIATE	58	24	0	0	99	
4	HA16200330	CONTOUR-INTERMEDIATE-DEP	58	24	0	1	99	
3	DA62450000	ROAD-PAVED-DIVIDED	40	28	0	0	28	

CCOGIF Feature Codes (3/26/98)

TYPE	CCOGIF	DESCRIPTION	CLASS	LEVEL	WEIGHT	STYLE	COLOUR	FONT
3	DA62500020	ROAD-PAVED-UNDIV-2 LANES	40	28	0	0	27	
3	DA62500040	ROAD-PAVED-UNDIV-4 LANES	40	28	0	3	35	
3	DA62450200	ROAD-PAVED-DIVIDED	40	28	0	0	99	
3	DA62500220	ROAD-PAVED-UNDIV-2 LANES	40	28	0	0	99	
3	DA62500240	ROAD-PAVED-UNDIV-4 LANES	40	28	0	3	99	
3	DD06000720	BRIDGE-ROAD-PAVED-2 LANE	43	28	0	0	10	
3	DD06000740	BRIDGE-ROAD-PAVED-4 LANE	43	28	0	0	11	
3	DD35100000	INTERCHANGE-RAMP	40	28	0	0	33	
3	DD49700000	OVERPASS/UNDERPASS	43	28	0	0	23	
3	DD49710000	OVERPASS/UNDERPASS	43	28	0	0	99	
3	DD77500000	TUNNEL-ROADWAY	43	28	0	0	12	
4	DA62450000	ROAD-PAVED-DIVIDED	40	28	0	0	28	
4	DA62500020	ROAD-PAVED-UNDIV-2 LANES	40	28	0	0	27	
4	DA62500040	ROAD-PAVED-UNDIV-4 LANES	40	28	0	3	35	
4	DA62450200	ROAD-PAVED-DIVIDED	40	28	0	0	99	
4	DA62500220	ROAD-PAVED-UNDIV-2 LANES	40	28	0	0	99	
4	DA62500240	ROAD-PAVED-UNDIV-4 LANES	40	28	0	3	99	
4	DD06000720	BRIDGE-ROAD-PAVED-2 LANE	43	28	0	0	10	
4	DD06000740	BRIDGE-ROAD-PAVED-4 LANE	43	28	0	0	11	
4	DD35100000	INTERCHANGE-RAMP	40	28	0	0	33	
4	DD49700000	OVERPASS/UNDERPASS	43	28	0	0	23	
4	DD49710000	OVERPASS/UNDERPASS	43	28	0	0	99	
4	DD77500000	TUNNEL-ROADWAY	43	28	0	0	12	
17	DA62450000	ROAD-PAVED-DIVIDED	65	28	0	0	28	66
17	DA62500020	ROAD-PAVED-UNDIVIDED	65	28	0	0	27	66
17	DA62500040	ROAD-PAVED-UNDIV-4 LANES	65	28	0	0	35	66
17	DA62550000	ROAD-PRIMARY SYMBOL	43	28	0	0	34	120
17	DA62550001	ROAD-PRIMARY TEXT	43	28	0	0	34	66
17	DD06000720	BRIDGE-ROAD-PAVED-2 LANE	43	28	0	0	10	120
17	DD06000740	BRIDGE-ROAD-PAVED-4 LANE	43	28	0	0	11	120
17	DD49700000	OVERPASS/UNDERPASS	43	28	0	0	23	120
17	DD77500000	TUNNEL-ROADWAY	43	28	0	0	12	120
3	DA62200020	ROAD-GRAVEL-2 LANES	40	29	0	3	29	
3	DD06000520	BRIDGE-ROAD-GRAVEL-2LANE	43	29	0	0	10	
4	DA62200020	ROAD-GRAVEL-2 LANES	40	29	0	3	29	
4	DD06000520	BRIDGE-ROAD-GRAVEL-2LANE	43	29	0	0	10	
3	DA62200210	ROAD-GRAVEL-2 LANES	40	29	0	3	99	
4	DA62200210	ROAD-GRAVEL-2 LANES	40	29	0	3	99	
17	DD06000520	BRIDGE-ROAD-GRAVEL-2LANE	43	29	0	0	10	120
17	DD63150000	ROAD-SECONDARY SYMBOL	43	29	0	0	36	120
17	DD63150001	ROAD SECONDARY NUMBER	43	29	0	0	36	66
3	DA62200010	ROAD-GRAVEL-1 LANE	40	30	0	7	31	
3	DA62200200	ROAD-GRAVEL-1 LANE	40	30	0	7	99	
3	DD06000510	BRIDGE-ROAD-GRAVEL-1LANE	43	30	0	0	10	
4	DA62200010	ROAD-GRAVEL-1 LANE	40	30	0	7	31	
4	DA62200200	ROAD-GRAVEL-1 LANE	40	30	0	7	99	
4	DD06000510	BRIDGE-ROAD-GRAVEL-1LANE	43	30	0	0	10	
17	DD06000510	BRIDGE-ROAD-GRAVEL-1LANE	43	30	0	0	10	120
3	DA62700000	ROAD-UNIMPROVED	41	31	0	2	32	
3	DA62700200	ROAD-UNIMPROVED	41	31	0	2	99	

CCOGIF Feature Codes (3/26/98)

TYPE	CCOGIF	DESCRIPTION	CLASS	LEVEL	WEIGHT	STYLE	COLOUR	FONT
3	DD06000950	BRIDGE-ROAD-UNIMPROVED	43	31	0	0	10	
4	DA62700000	ROAD-UNIMPROVED	41	31	0	2	32	
4	DA62700200	ROAD-UNIMPROVED	41	31	0	2	99	
4	DD06000950	BRIDGE-ROAD-UNIMPROVED	43	31	0	0	10	
17	DD06000950	BRIDGE-ROAD-UNIMPROVED	43	31	0	0	10	120
3	DC76500000	TRAIL-TRUCK	42	32	0	5	105	
3	DC76500200	TRAIL-TRUCK	42	32	0	5	99	
3	DD06150700	BRIDGE-TRAIL-TRUCK	43	32	0	0	10	
4	DC76500000	TRAIL-TRUCK	42	32	0	5	105	
4	DC76500200	TRAIL-TRUCK	42	32	0	5	99	
4	DD06150700	BRIDGE-TRAIL-TRUCK	43	32	0	0	10	
17	DD06150700	BRIDGE-TRAIL-TRUCK	43	32	0	0	10	120
3	DC76100000	TRAIL/CUTLINE	42	33	0	5	106	
4	DC76100000	TRAIL/CUTLINE	42	33	0	5	106	
3	DC76160000	TRAIL/CUTLINE	42	33	0	5	99	
4	DC76160000	TRAIL/CUTLINE	42	33	0	5	99	
3	DD05950800	BRIDGE-RAILWAY-TRESTLE	43	34	0	0	11	
3	DD77450000	TUNNEL-RAILWAY	43	34	0	0	13	
3	DE56950000	RAIL LINE-ABANDONED	40	34	0	4	3	
3	DE57000000	RAIL LINE-DOUBLE TRACK	40	34	0	7	5	
3	DE57100000	RAIL LINE-MULTIPLE TRACK	40	34	0	2	6	
3	DE57250000	RAIL LINE-SINGLE TRACK	40	34	0	0	4	
3	DD77450000	TUNNEL-RAILWAY	43	34	0	0	13	
3	DE56950200	RAIL LINE-ABANDONED	40	34	0	4	99	
3	DE57000200	RAIL LINE-DOUBLE TRACK	40	34	0	7	99	
3	DE57100200	RAIL LINE-MULTIPLE TRACK	40	34	0	2	99	
3	DE57250200	RAIL LINE-SINGLE TRACK	40	34	0	0	99	
4	DD05950800	BRIDGE-RAILWAY-TRESTLE	43	34	0	0	11	
4	DD77450000	TUNNEL-RAILWAY	43	34	0	0	13	
4	DE56950000	RAIL LINE-ABANDONED	40	34	0	4	3	
4	DE57000000	RAIL LINE-DOUBLE TRACK	40	34	0	7	5	
4	DE57100000	RAIL LINE-MULTIPLE TRACK	40	34	0	2	6	
4	DE57250000	RAIL LINE-SINGLE TRACK	40	34	0	0	4	
4	DE56950200	RAIL LINE-ABANDONED	40	34	0	4	99	
4	DE57000200	RAIL LINE-DOUBLE TRACK	40	34	0	7	99	
4	DE57100200	RAIL LINE-MULTIPLE TRACK	40	34	0	2	99	
4	DE57250200	RAIL LINE-SINGLE TRACK	40	34	0	0	99	
17	DD05950600	BRIDGE-RAILWAY-TRESTLE	43	34	0	0	11	120
17	DD77450000	TUNNEL-RAILWAY	43	34	0	0	13	120
17	DE56950000	RAIL LINE-ABANDONED	40	34	0	0	3	67
17	DE57000000	RAIL LINE-DOUBLE TRACK	65	34	0	0	5	67
17	DE57100000	RAIL LINE-MULTIPLE TRACK	65	34	0	0	6	67
17	DE57250000	RAIL LINE-SINGLE TRACK	65	34	0	0	4	67
3	DD05950000	BRIDGE-RAILWAY-SPUR	43	35	0	0	11	
3	DF57300000	RAIL LINE-SPUR	40	35	0	0	7	
3	DF57300200	RAIL LINE-SPUR	40	35	0	0	99	
4	DD05950000	BRIDGE-RAILWAY-SPUR	43	35	0	0	11	
4	DF57300000	RAIL LINE-SPUR	40	35	0	0	7	
4	DF57300200	RAIL LINE-SPUR	40	35	0	0	99	

CCOGIF Feature Codes (3/26/98)

TYPE	CCOGIF	DESCRIPTION	CLASS	LEVEL	WEIGHT	STYLE	COLOUR	FONT
17	DF57300000	RAIL LINE-SPUR	65	35	0	0	7	67
17	AR54500000	RAILWAY POINT TEXT	65	36	1	0	120	66
17	AR54500600	RAILWAY POINT	28	36	0	0	120	120
3	EZ40700000	UNSPECIFIED FEATURE	42	37	0	1	107	
4	EZ40700000	UNSPECIFIED FEATURE	42	37	0	1	107	
3	EA75050000	TRANSMISSION LINE-MAJOR	46	39	0	7	22	
4	EA75050000	TRANSMISSION LINE-MAJOR	46	39	0	7	22	
3	EA52550000	MAJOR PIPELINE	46	40	0	4	20	
4	EA52550000	MAJOR PIPELINE	46	40	0	4	20	
3	BG22100400	STATION-POWER-GENERATING	21	41	0	0	9	
3	BG58750000	REFINERY-BUILDING	21	41	0	0	10	
3	BZ53500000	PLANT-GAS	21	41	0	0	11	
4	BG22100400	STATION-POWER-GENERATING	21	41	0	0	9	
4	BG58750000	REFINERY-BUILDING	21	41	0	0	10	
4	BZ53500000	PLANT-GAS	21	41	0	0	11	
17	BG22100400	STATION-POWER-GENERATING	21	41	0	0	9	66
17	BG58750000	REFINERY-BUILDING	21	41	0	0	10	66
17	BZ53500000	PLANT-GAS	21	41	0	0	11	66
17	GF79600000	OIL & GAS ACTIVITY SITE	21	41	0	0	8	120
17	GF79650000	OIL & GAS ACTIVITY SITE	21	41	0	0	7	120
3	AQ00750000	RUNWAY-AIRSTRIP	14	42	0	0	17	
3	AQ63700000	RUNWAY-AIRFIELD	14	42	0	0	16	
3	AQ63750000	RUNWAY-AIRPORT	14	42	0	0	15	
4	AQ00750000	RUNWAY-AIRSTRIP	14	42	0	0	17	
4	AQ63700000	RUNWAY-AIRFIELD	14	42	0	0	16	
4	AQ63750000	RUNWAY-AIRPORT	14	42	0	0	15	
17	AQ00650000	AIRFIELD	65	42	0	0	16	66
17	AQ00700000	AIRPORT	65	42	0	0	15	66
17	AQ00750000	AIRSTRIP	65	42	0	0	17	66
17	AQ32500000	HELIPAD (AFS)	14	42	0	0	18	120
17	AQ32550000	HELIPORT	14	42	0	0	14	120
17	AQ39000000	LANDING-FLOAT	14	42	0	0	19	120
2	AD28600001	PERMANENT SAMPLE PLOT	5	43	0	0	20	
3	AD28600001	PERMANENT SAMPLE PLOT	5	43	0	0	20	
4	AD28600001	PERMANENT SAMPLE PLOT	5	43	0	0	20	
17	AD28600001	PERMANENT SAMPLE PLOT	5	43	0	0	20	66
17	AL58600000	FOREST RECREATION AREA	10	43	0	0	29	120
17	AL58600001	FOREST RECREATION AREA	10	43	0	0	29	66
3	AL58600000	FOREST RECREATION AREA	10	43	0	0	29	
4	AL58600000	FOREST RECREATION AREA	10	43	0	0	29	
17	AL58650000	PROV RECREATIONAL AREA	10	43	0	0	28	120
17	AL58650001	PROV RECREATIONAL AREA	10	43	0	0	28	66
3	AL58650000	PROV RECREATIONAL AREA	10	43	0	0	28	
4	AL58650000	PROV RECREATIONAL AREA	10	43	0	0	28	
17	BF07100000	CABIN-FORESTRY	5	43	0	0	34	120
17	BF07100001	CABIN-FORESTRY	5	43	0	0	34	66

CCOGIF Feature Codes (3/26/98)

TYPE	CCOGIF	DESCRIPTION	CLASS	LEVEL	WEIGHT	STYLE	COLOUR	FONT
17	BF32300000	HEADQUARTERS-FORESTRY	5	43	0	0	32	120
17	BF32300001	HEADQUARTERS-FORESTRY	5	43	0	0	32	66
17	BF41150800	LOOKOUT TOWER	5	43	0	0	26	120
17	BF41150801	LOOKOUT TOWER	5	43	0	0	26	66
17	BF70700000	STATION-RANGER	5	43	0	0	33	120
17	BF70700001	STATION-RANGER	5	43	0	0	33	66
17	CC74750000	MAJOR TOWER/MAST	46	44	0	0	110	120
17	CC74740000	MAJOR TOWER/MAST	46	44	0	0	110	66
3	GM48776900	LEADER LINE	45	45	0	0	0	
4	GM48776900	LEADER LINE	45	45	0	0	0	
17	GM48776900	LEADER SYMBOL	45	45	0	0	0	120
17	HB51850000	PHYSICAL FEATURE	65	46	0	0	13	66
3	JA12900000	CLEARING	5	47	0	0	20	
4	JA12900000	CLEARING	5	47	0	0	20	
17	JA12900000	CLEARING	5	47	0	0	20	66
3	AG52950000	PIT-SAND/GRAVEL	6	48	0	3	3	
3	AG64535000	MINE-OPEN-OPERATION	6	48	0	3	4	
3	BG43000000	MILL SITE	6	48	0	3	122	
3	GB55150000	TAILING PIPE/POND/DUMP	13	48	0	3	12	
4	AG52950000	PIT-SAND/GRAVEL	6	48	0	3	3	
4	AG64535000	MINE-OPEN-OPERATION	6	48	0	3	4	
4	BG43000000	MILL SITE	6	48	0	3	122	
4	GB55150000	TAILING PIPE/POND/DUMP	13	48	0	3	12	
17	AG52950000	PIT-SAND/GRAVEL	65	48	0	0	3	66
17	AG64535000	MINE-OPEN OPERATION	65	48	0	0	4	66
17	BG43000000	MILL SITE	65	48	0	0	122	66
17	GB55150000	TAILING PIPE/POND/DUMP	65	48	0	0	12	66
3	AL67700000	AREA-SKI	10	49	0	3	123	
4	AL67700000	AREA-SKI	10	49	0	3	123	
17	AL67700000	AREA-SKI	65	49	0	0	123	66
3	AR06600000	BOUNDARY-BUILT UP AREA	9	50	2	0	124	
3	AR12850000	BOUNDARY-CITY	9	50	4	0	113	
3	AR12852000	BOUNDARY-CITY	9	50	4	0	99	
4	AR06600000	BOUNDARY-BUILT UP AREA	9	50	2	0	124	
4	AR12850000	BOUNDARY-CITY	9	50	4	0	113	
4	AR12852000	BOUNDARY-CITY	9	50	4	0	99	
17	AR12850000	CITY	65	50	4	0	113	66
3	AR75100000	BOUNDARY-TOWN	9	51	2	0	114	
4	AR75100000	BOUNDARY-TOWN	9	51	2	0	114	
3	AR75120000	BOUNDARY-TOWN	9	51	2	0	99	
4	AR75120000	BOUNDARY-TOWN	9	51	2	0	99	
17	AR75100000	TOWN TEXT	65	51	2	0	114	66
3	AR78250000	BOUNDARY-VILLAGE	9	52	2	0	116	
3	AR78320000	BOUNDARY-VILLAGE	9	52	2	0	99	

CCOGIF Feature Codes (3/26/98)

TYPE	CCOGIF	DESCRIPTION	CLASS	LEVEL	WEIGHT	STYLE	COLOUR	FONT
3	AR78550000	BOUNDARY-VILLAGE-SUMMER	9	52	2	0	118	
3	AR78550200	BOUNDARY-VILLAGE-SUMMER	9	52	2	0	99	
4	AR78250000	BOUNDARY-VILLAGE	9	52	2	0	116	
4	AR78320000	BOUNDARY-VILLAGE	9	52	2	0	99	
4	AR78550000	BOUNDARY-VILLAGE-SUMMER	9	52	2	0	118	
4	AR78550200	BOUNDARY-VILLAGE-SUMMER	9	52	2	0	99	
17	AR78250000	VILLAGE	65	52	1	0	116	66
17	AR78550000	VILLAGE-SUMMER	65	52	1	0	118	66
17	AR31650001	LOC/HAM/P.O./PRT-OF-ENT	9	53	1	0	119	66
17	AR31650000	LOC/HAM/P.O./PRT-OF-ENT	9	53	0	0	119	120
3	FA35150000	BOUNDARY-INTERNATIONAL	47	55	3	7	115	
3	FA35300000	BOUNDARY-INTERPROVINCIAL	47	55	3	6	117	
4	FA35150000	BOUNDARY-INTERNATIONAL	47	55	3	7	115	
4	FA35300000	BOUNDARY-INTERPROVINCIAL	47	55	3	6	117	
3	FA35170000	BOUNDARY-INTERNATIONAL	47	55	3	7	99	
3	FA35320000	BOUNDARY-INTERPROVINCIAL	47	55	3	6	99	
4	FA35170000	BOUNDARY-INTERNATIONAL	47	55	3	7	99	
4	FA35320000	BOUNDARY-INTERPROVINCIAL	47	55	3	6	99	
17	FA35150000	INTERNATIONAL BOUNDARY	47	55	2	0	115	66
17	FA35300000	INTERPROVINCIAL BOUNDARY	47	55	2	0	117	66
3	AJ02650000	BOUNDARY-BASE-MILITARY	8	56	2	2	111	
3	AJ58050000	BOUNDARY-RANGE-MILITARY	8	56	2	0	112	
3	AL50300000	BOUNDARY-PARK-NATIONAL	5	56	4	0	101	
4	AJ02650000	BOUNDARY-BASE-MILITARY	8	56	2	0	111	
4	AJ58050000	BOUNDARY-RANGE-MILITARY	8	56	2	0	112	
4	AL50300000	BOUNDARY-PARK-NATIONAL	5	56	4	0	101	
3	AJ02650200	BOUNDARY-BASE-MILITARY	8	56	2	0	99	
3	AJ58020000	BOUNDARY-RANGE-MILITARY	8	56	2	0	99	
3	AL50300200	BOUNDARY-PARK-NATIONAL	5	56	4	0	99	
4	AJ02650200	BOUNDARY-BASE-MILITARY	8	56	2	0	99	
4	AJ58020000	BOUNDARY-RANGE-MILITARY	8	56	2	0	99	
4	AL50300200	BOUNDARY-PARK-NATIONAL	5	56	4	0	99	
17	AJ02650000	BASE-MILITARY	65	56	1	0	111	66
17	AJ58050000	RANGE-MILITARY	65	56	1	0	112	66
17	AL50300000	PARK-NATIONAL	5	56	2	0	101	66
3	AD28600000	BOUNDARY-RESERVE-FOREST	5	57	2	0	96	
3	AD80250000	BOUNDARY-AREA-WILDERNESS	5	57	4	0	103	
3	AL48050000	BOUNDARY-AREA-NATURAL	5	57	1	0	104	
3	AL50350000	BOUNDARY-PARK-PROVINCIAL	5	57	4	0	102	
4	AD28600000	BOUNDARY-RESERVE-FOREST	5	57	2	0	96	
4	AD80250000	BOUNDARY-AREA-WILDERNESS	5	57	4	0	103	
4	AL48050000	BOUNDARY-AREA-NATURAL	5	57	1	0	104	
4	AL50350000	BOUNDARY-PARK-PROVINCIAL	5	57	4	0	102	
3	AD28602000	BOUNDARY-RESERVE-FOREST	5	57	2	0	99	
3	AD80260000	BOUNDARY-AREA-WILDERNESS	5	57	4	0	99	
3	AL48052000	BOUNDARY-AREA-NATURAL	5	57	1	0	99	
3	AL50350200	BOUNDARY-PARK-PROVINCIAL	5	57	4	0	99	
4	AD28602000	BOUNDARY-RESERVE-FOREST	5	57	2	0	99	
4	AD80260000	BOUNDARY-AREA-WILDERNESS	5	57	4	0	99	

CCOGIF Feature Codes (3/26/98)

TYPE	CCOGIF	DESCRIPTION	CLASS	LEVEL	WEIGHT	STYLE	COLOUR	FONT
4	AL48052000	BOUNDARY-AREA-NATURAL	5	57	1	0	99	
4	AL50350200	BOUNDARY-PARK-PROVINCIAL	5	57	4	0	99	
17	AD28600000	FOREST RESERVE	5	57	2	0	96	66
17	AD80250000	WILDERNESS AREA	5	57	2	0	103	66
17	AL08550000	AT CAMPGROUND	10	57	0	0	30	120
17	AL08550001	AT CAMPGROUND	10	57	0	0	30	66
17	AL48050000	NATURAL AREA	5	57	1	0	104	66
17	AL50350000	PARK-PROVINCIAL	5	57	1	0	102	66
3	AR17500000	BOUNDARY-COUNTY	5	58	6	0	125	
3	AR34750000	BOUNDARY-IMPROVEMENT DIST	5	58	4	0	5	
3	AR47350000	BOUNDARY-MUNICIPAL DIST	5	58	5	0	126	
3	AR68600000	BOUNDARY-SPECIAL AREA	5	58	4	0	2	
4	AR17500000	BOUNDARY-COUNTY	5	58	6	0	125	
4	AR34750000	BOUNDARY-IMPROVEMENT DIST	5	58	4	0	5	
4	AR47350000	BOUNDARY-MUNICIPAL DIST	5	58	5	0	126	
4	AR68600000	BOUNDARY-SPECIAL AREA	5	58	4	0	2	
3	AR17502000	BOUNDARY-COUNTY	5	58	6	0	99	
3	AR34752000	BOUNDARY-IMPROVEMENT DIST	5	58	4	0	99	
3	AR47350010	BOUNDARY-MUNICIPAL DIST	5	58	5	0	99	
3	AR68602000	BOUNDARY-SPECIAL AREA	5	58	4	0	99	
4	AR17502000	BOUNDARY-COUNTY	5	58	6	0	99	
4	AR34752000	BOUNDARY-IMPROVEMENT DIST	5	58	4	0	99	
4	AR47350010	BOUNDARY-MUNICIPAL DIST	5	58	5	0	99	
4	AR68602000	BOUNDARY-SPECIAL AREA	5	58	4	0	99	
17	AR17500000	COUNTY	5	58	2	0	125	66
17	AR34750000	IMPROVEMENT DISTRICT	5	58	1	0	5	66
17	AR47350000	MUNICIPAL DISTRICT	5	58	1	0	126	66
17	AR68600000	SPECIAL AREA	5	58	1	0	2	66
3	AF34850000	BOUNDARY-RESERVE-INDIAN	10	59	2	0	6	
3	AF65750000	BDY-SETTLEMENT-METIS	10	59	2	0	109	
4	AF34850000	BOUNDARY-RESERVE-INDIAN	10	59	2	0	6	
4	AF65750000	BDY-SETTLEMENT-METIS	10	59	2	0	109	
3	AF34854000	BOUNDARY-RESERVE-INDIAN	10	59	2	0	99	
3	AF65750200	BDY-SETTLEMENT-METIS	10	59	2	0	99	
4	AF34852000	BOUNDARY-RESERVE-INDIAN	10	59	2	0	99	
4	AF65750200	BDY-SETTLEMENT-METIS	10	59	2	0	99	
17	AF34850000	INDIAN RESERVE	10	59	1	0	6	66
17	AF65750000	SETTLEMENT-METIS	10	59	1	0	109	66
3	ZZ99999999	ERROR	1	63	0	0	44	
4	ZZ99999999	ERROR	1	63	0	0	44	
17	ZZ99999999	ERROR	1	63	0	0	44	1

Appendix 4. Naming Convention for Digital Files

Overview

Spatial data is found on the enclosed compact disc. Digital files have been separated into sub-directories based on the 1:50 000 scale National Topographic Service (NTS) map sheet they represent (e.g., NTS84J13). All file names follow conventional 8.3 DOS naming conventions. The naming convention for all digital files reflects both the feature type contained within the NTS map sheet file. The first three characters are reserved for feature type. For instance a file beginning with the prefix PAV refers to paved roads. A description of prefixes follows:

Prefix	File Description
BND	Map Sheet Boundary UTM
BTM	Map Sheet Boundary 10°TM
CLS	Classified ground cover
DEM	Digital elevation model
EOP	EOP3 project files (ArcView)
FMU	Forest management units
GRA	Loose surface roads
HYD	Hydrography (Lakes, reservoirs, rivers, streams and creeks)
IMG	Image files (.TIF and .PCI EASI/PACE PIX formats)
MET	Metadata files
PAV	Paved roads
PRO	Provincial protected areas
TRL	Trails, truck trails and cutlines
TPR	ATS Grid
UTM	UTM tic markers

The next five characters represent the NTS map sheet in question. For example, the file CLS84J13 is a classified ground cover file for the NTS map sheet 84 J/13. The file PAV82J10 represents paved road information for the NTS map sheet 82 J/10. As well, there is a metadata form associated with each spatial file. These files have an MET prefix followed by the file name of the data to which they refer. A metadata example is included as part of Appendix 5.



GAIA
CONSULTANTS INC.

EOP3 METADATA STRUCTURE

Data Set Name: BND72E02

Data Set Description

Map sheet 72 E/2 boundary, in utm projection.

IDENTIFICATION INFORMATION

Digital File Owner: Alberta Environmental Protection

Originator(s) (raw data): AEP - RDD

Last Data Editor: Ken Mott

Publication Information:

Publication Place: Calgary, AB

Publisher: RDD/GAIA

Date Last Modified (yr/mo/dy): 98/03/27

Time Period of Content:

Time of Data Collection: Unknown

Progress: Complete

Spatial Domain:

NTS Sheet(s): 72 E/2

ATS Coverage: Tp 1-3, R 4-8

DATA QUALITY INFORMATION

Source Information:

Data Type: Vector

If Raster, Size (in pixels):

Resolution (m):

Scale: 1: 50 000

Projection: UTM Zone 12

Datum: NAD 27

Reference System: UTM

Processing Information: Generated from map sheet boundary.

Processing Date: 98/03/27

Processor: Ken Mott

ENTITY & ATTRIBUTE INFORMATION

Type: Polygon

Attributes (excluding internal codes):

<i>LABEL</i>	<i>DEFINITION</i>
NONE	N/A

STORAGE & DISTRIBUTION INFORMATION

Storage:

Format: ARC/INFO Export Files

Approximate File Size (MB): 1

EOP3 METADATA STRUCTURE

Data Set Name: BTM72E02

Data Set Description

Map sheet 72 E/2 boundary, in 10 Degree TM projection.

IDENTIFICATION INFORMATION

Digital File Owner: Alberta Environmental Protection

Originator(s) (raw data): AEP - RDD

Last Data Editor: Ken Mott

Publication Information:

Publication Place: Calgary, AB

Publisher: RDD/GAIA

Date Last Modified (yr/mo/dy): 98/03/27

Time Period of Content:

Time of Data Collection: Unknown

Progress: Complete

Spatial Domain:

NTS Sheet(s): 72 E/2

ATS Coverage: Tp 1-3, R 4-8

DATA QUALITY INFORMATION

Source Information:

Data Type: Vector

If Raster, Size (in pixels):

Resolution (m):

Scale: 1: 50 000

Projection: Transverse Mercator

Datum: NAD 27

Reference System: 10 Degree TM

Processing Information: Generated from map sheet boundary.

Processing Date: 98/03/27

Processor: Ken Mott

ENTITY & ATTRIBUTE INFORMATION

Type: Polygon

Attributes (excluding internal codes):

<i>LABEL</i>	<i>DEFINITION</i>
NONE	N/A

STORAGE & DISTRIBUTION INFORMATION

Storage:

Format: ARC/INFO Export Files

Approximate File Size (MB): 1

EOP3 METADATA STRUCTURE

Data Set Name: CLS72E02

Data Set Description

Classified land cover coverage of map sheet 72 E/2, based on the EOP3 Ground Cover Classification Scheme.

IDENTIFICATION INFORMATION

Digital File Owner: Alberta Environmental Protection

Originator(s) (raw data): AEP - RDD

Last Data Editor: Ken Mott

Publication Information:

Publication Place: Calgary, AB

Publisher: RDD/GAIA

Date Last Modified (yr/mo/dy): 98/03/27

Time Period of Content:

Time of Data Capture: 96/07/03

Progress: Complete

Time of Data Processing: 1998

Spatial Domain:

NTS Sheet(s): 72 E/2

ATS Coverage: Tp 1-3, R 4-8

DATA QUALITY INFORMATION

Source Information:

Data Type: Vector

If Raster, Size (in pixels):

Resolution (m):

Scale: 1: 50 000

Projection: UTM Zone 12

Datum: NAD 27

Reference System: UTM

Processing Information: Generated from PCI files and attributes added. Polygons smaller than 0.5 ha have been eliminated.

Processing Date: 98/03/27

Processor: Ken Mott

ENTITY & ATTRIBUTE INFORMATION

Type: Polygon

Attributes (excluding internal codes):

<i>LABEL</i>	<i>DEFINITION</i>
LNDCOVER	Landcover code (numeric)
DESCRIPTION	Literal description of landcover code
FORFU_TYPE	FBP fuel type (numeric)
FORFU_DESC	Description of FBP fuel type

STORAGE & DISTRIBUTION INFORMATION

Storage:

Format: ARC/INFO Export Files

Approximate File Size (MB): 1



GAIA
CONSULTANTS INC.

EOP3 METADATA STRUCTURE

Data Set Name: EOP72E02.APR

Data Set Description

Arc View project file showing classified imagery and linear data for map sheet 72 E/2.

IDENTIFICATION INFORMATION

Digital File Owner: Alberta Environmental Protection

Originator(s) (raw data): AEP - RDD

Last Data Editor: Ken Mott

Publication Information:

Publication Place: Calgary, AB

Publisher: RDD/GAIA

Date Last Modified (yr/mo/dy): 98/03/27

Time Period of Content:

Time of Data Collection: Unknown

Progress: Complete

Spatial Domain:

NTS Sheet(s): 72 E/2

ATS Coverage: Tp 1-3, R 4-8

DATA QUALITY INFORMATION

Source Information:

Data Type: Image

If Raster, Size (in pixels):

Resolution (m):

Scale: 1: 50 000

Projection: UTM Zone 12

Datum: NAD 27

Reference System: UTM

Processing Information: Generated by GAIA Consultants Inc.

Processing Date: 98/03/27

Processor: Ken Mott

ENTITY & ATTRIBUTE INFORMATION

Type: Arc View Project File

Attributes (excluding internal codes):

<i>LABEL</i>	<i>DEFINITION</i>
NONE	N/A

STORAGE & DISTRIBUTION INFORMATION

Storage:

Format: ASCII

Approximate File Size (MB): 1



EOP3 METADATA STRUCTURE

Data Set Name: GRA72E02

Data Set Description

Loose surface roads for map sheet 72 E/2.

IDENTIFICATION INFORMATION

Digital File Owner: Alberta Environmental Protection

Originator(s) (raw data): AEP - RDD

Last Data Editor: Ken Mott

Publication Information:

Publication Place: Calgary, AB

Publisher: RDD/GAIA

Date Last Modified (yr/mo/dy): 98/03/27

Time Period of Content:

Time of Data Collection: Unknown

Progress: Complete

Spatial Domain:

NTS Sheet(s): 72 E/2

ATS Coverage: Tp 1-3, R 4-8

DATA QUALITY INFORMATION

Source Information:

Data Type: Vector

If Raster, Size (in pixels):

Resolution (m):

Scale: 1: 50 000

Projection: UTM Zone 12

Datum: NAD 27

Reference System: UTM

Processing Information: Generated from government files. Selected from provincial land use/access 1:20 000 files.

Processing Date: 98/03/27

Processor: Ken Mott

ENTITY & ATTRIBUTE INFORMATION

Type: Arc

Attributes (excluding internal codes):

<i>LABEL</i>	<i>DEFINITION</i>
CCOGIF	Provincial ccogif codes.
DESCRIPTION	Literal description of feature.

STORAGE & DISTRIBUTION INFORMATION

Storage:

Format: ARC/INFO Export Files

Approximate File Size (MB): 1



GAIA
CONSULTANTS INC.

EOP3 METADATA STRUCTURE

Data Set Name: HYD72E02

Data Set Description

Hydrography, including lakes, rivers, streams, reservoirs, and creeks, for map sheet 72 E/2.

IDENTIFICATION INFORMATION

Digital File Owner: Alberta Environmental Protection

Originator(s) (raw data): AEP - RDD

Last Data Editor: Ken Mott

Publication Information:

Publication Place: Calgary, AB

Publisher: RDD/GAIA

Date Last Modified (yr/mo/dy): 98/03/27

Time Period of Content:

Time of Data Collection: Unknown

Progress: Complete

Spatial Domain:

NTS Sheet(s): 72 E/2

ATS Coverage: Tp 1-3, R 4-8

DATA QUALITY INFORMATION

Source Information:

Data Type: Vector

If Raster, Size (in pixels):

Resolution (m):

Scale: 1: 50 000

Projection: UTM Zone 12

Datum: NAD 27

Reference System: UTM

Processing Information: Generated from government files. Selected from provincial land use/access 1:20 000 files.

Processing Date: 98/03/27

Processor: Ken Mott

ENTITY & ATTRIBUTE INFORMATION

Type: Arc

Attributes (excluding internal codes):

<i>LABEL</i>	<i>DEFINITION</i>
CCOGIF	Provincial ccogif codes.
DESCRIPTION	Literal description of feature.

STORAGE & DISTRIBUTION INFORMATION

Storage:

Format: ARC/INFO Export Files

Approximate File Size (MB): 1



EOP3 METADATA STRUCTURE

Data Set Name: IMG72E02.ZIP

Data Set Description

Georeferenced PCI Easi/Pace file containing channels having TM bands 2, 3, 4, 5, 7 and a classified image.

DENTIFICATION INFORMATION

Digital File Owner: Alberta Environmental Protection

Originator(s) (raw data): AEP - RDD

Last Data Editor: Ken Mott

Publication Information:

Publication Place: Calgary, AB

Publisher: RDD/GAIA

Date Last Modified (yr/mo/dy): 98/03/27

Time Period of Content:

Time of Data Capture: 96/07/03

Progress: Complete

Time of Data Processing: 1998

Spatial Domain:

NTS Sheet(s): 72 E/2

ATS Coverage: Tp 1-3, R 4-8

DATA QUALITY INFORMATION

Source Information:

Data Type: Multi-band image file

If Raster, Size (in pixels):

Resolution (m): 25

Scale: 1: 50 000

Projection: UTM Zone 12

Datum: NAD 27

Reference System: UTM

Processing Information: Generated from raw Landsat TM data in PCI Easi/Pace following the EOP3 Ground Cover Classification Scheme using isodata clustering methods.

Processing Date: 98/03/27

Processor: Ken Mott

ENTITY & ATTRIBUTE INFORMATION

Type: Image

Attributes (excluding internal codes):

<i>LABEL</i>	<i>DEFINITION</i>
NONE	N/A

STORAGE & DISTRIBUTION INFORMATION

Storage:

Format: WinZip 6.1/PCI

Approximate File Size (MB): 13



GAIA
CONSULTANTS INC.

EOP3 METADATA STRUCTURE

Data Set Name: PAV72E02

Data Set Description

Paved roads of map sheet 72 E/2.

IDENTIFICATION INFORMATION

Digital File Owner: Alberta Environmental Protection

Originator(s) (raw data): AEP - RDD

Last Data Editor: Ken Mott

Publication Information:

Publication Place: Calgary, AB

Publisher: RDD/GAIA

Date Last Modified (yr/mo/dy): 98/03/27

Time Period of Content:

Time of Data Collection: Unknown

Progress: Complete

Spatial Domain:

NTS Sheet(s): 72 E/2

ATS Coverage: Tp 1-3, R 4-8

DATA QUALITY INFORMATION

Source Information:

Data Type: Vector

If Raster, Size (in pixels):

Resolution (m):

Scale: 1: 50 000

Projection: UTM

Datum: NAD 27

Reference System: UTM

Processing Information: Generated from government files. Selected from provincial land use/access 1:20 000 files.

Processing Date: 98/03/27

Processor: Ken Mott

ENTITY & ATTRIBUTE INFORMATION

Type: Arc

Attributes (excluding internal codes):

<i>LABEL</i>	<i>DEFINITION</i>
CCOGIF	Provincial ccogif codes.
DESCRIPTION	Literal description of feature.

STORAGE & DISTRIBUTION INFORMATION

Storage:

Format: ARC/INFO Export Files

Approximate File Size (MB): 1



EOP3 METADATA STRUCTURE

Data Set Name: PRO72E02

Data Set Description

Vector file of Alberta's Protected Areas, clipped to map sheet 72 E/2.

IDENTIFICATION INFORMATION

Digital File Owner: Alberta Environmental Protection

Originator(s) (raw data): AEP - RDD

Last Data Editor: Ken Mott

Publication Information:

Publication Place: Calgary, AB

Publisher: RDD/GAIA

Date Last Modified (yr/mo/dy): 98/03/27

Time Period of Content:

Time of Data Collection: Originally provided by Alberta Heritage.

Progress: In-progress

Spatial Domain:

NTS Sheet(s): 72 E/2

ATS Coverage: Tp 1-3, R 4-8

DATA QUALITY INFORMATION

Source Information:

Data Type: Vector

If Raster, Size (in pixels):

Resolution (m):

Scale: 1: 50 000

Projection: UTM Zone 12

Datum: NAD 27

Reference System: UTM

Processing Information: Clipped from government files.

Processing Date: 98/03/27

Processor: Ken Mott

ENTITY & ATTRIBUTE INFORMATION

Type: Polygon

Attributes (excluding internal codes):

<i>LABEL</i>	<i>DEFINITION</i>
TYPE	Type of protected area. (WA = Wilderness Area; ER = Ecological Reserve; NA = Natural Area; PP = Provincial Park; NP = National Park; WP = Wilderness Park)
STATUS	Legislative status. (OC = Order-in-Council; PNT = Protective Notation Reservation; APP = Application for reservation; CNT = Consultative Notation reservation; EZE = Easement; PEND = Pending application for reservation; UK = Unknown)

STORAGE & DISTRIBUTION INFORMATION

Storage:

Format: ARC/INFO Export Files

Approximate File Size (MB): 1

EOP3 METADATA STRUCTURE

Data Set Name: TPR72E02

Data Set Description

ATS Grid for map sheet 72 E/2.

IDENTIFICATION INFORMATION

Digital File Owner: Alberta Environmental Protection

Originator(s) (raw data): AEP - RDD

Last Data Editor: Ken Mott

Publication Information:

Publication Place: Calgary, AB

Publisher: RDD/GAIA

Date Last Modified (yr/mo/dy): 98/03/27

Time Period of Content:

Time of Data Collection: Unknown

Progress: Complete

Spatial Domain:

NTS Sheet(s): 72 E/2

ATS Coverage: Tp 1-3, R 4-8

DATA QUALITY INFORMATION

Source Information:

Data Type: Vector

If Raster, Size (in pixels):

Resolution (m):

Scale: 1: 50 000

Projection: UTM Zone 12

Datum: NAD 27

Reference System: UTM

Processing Information: Generated from government files.

Processing Date: 98/03/27

Processor: Ken Mott

ENTITY & ATTRIBUTE INFORMATION

Type: Polygon

Attributes (excluding internal codes):

<i>LABEL</i>	<i>DEFINITION</i>
TRM	TownshipRangeMeridian

STORAGE & DISTRIBUTION INFORMATION

Storage:

Format: ARC/INFO Export Files

Approximate File Size (MB): 1

EOP3 METADATA STRUCTURE

Data Set Name: TRL72E02

Data Set Description

Trails, truck trails, and cutlines of map sheet 72 E/2.

IDENTIFICATION INFORMATION

Digital File Owner: Alberta Environmental Protection

Originator(s) (raw data): AEP - RDD

Last Data Editor: Ken Mott

Publication Information:

Publication Place: Calgary, AB

Publisher: RDD/GAIA

Date Last Modified (yr/mo/dy): 98/03/27

Time Period of Content:

Time of Data Collection: Unknown

Progress: Complete

Spatial Domain:

NTS Sheet(s): 72 E/2

ATS Coverage: Tp 1-3, R 4-8

DATA QUALITY INFORMATION

Source Information:

Data Type: Vector

If Raster, Size (in pixels):

Resolution (m):

Scale: 1: 50 000

Projection: UTM Zone 12

Datum: NAD 27

Reference System: UTM

Processing Information: Generated from government files. Selected from provincial land use/access 1:20 000 files.

Processing Date: 98/03/27

Processor: Ken Mott

ENTITY & ATTRIBUTE INFORMATION

Type: Arc

Attributes (excluding internal codes):

<i>LABEL</i>	<i>DEFINITION</i>
CCOGIF	Provincial ccogif codes.
DESCRIPTION	Literal description of feature.

STORAGE & DISTRIBUTION INFORMATION

Storage:

Format: ARC/INFO Export Files

Approximate File Size (MB): 1



EOP3 METADATA STRUCTURE

Data Set Name: UTM72E02

Data Set Description

UTM tics (line) along border of map sheet 72 E/2.

IDENTIFICATION INFORMATION

Digital File Owner: Alberta Environmental Protection

Originator(s) (raw data): AEP - RDD

Last Data Editor: Ken Mott

Publication Information:

Publication Place: Calgary, AB

Publisher: RDD/GAIA

Date Last Modified (yr/mo/dy): 98/03/27

Time Period of Content:

Time of Data Collection: Unknown

Progress: Complete

Spatial Domain:

NTS Sheet(s): 72 E/2

ATS Coverage: Tp 1-3, R 4-8 .

DATA QUALITY INFORMATION

Source Information:

Data Type: Vector

If Raster, Size (in pixels):

Scale: 1: 50 000

Datum: NAD 27

Processing Information: Generated from government files.

Processing Date: 98/03/27

Resolution (m):

Projection: UTM Zone 12

Reference System: UTM

Processor: Ken Mott

ENTITY & ATTRIBUTE INFORMATION

Type: Arc

Attributes (excluding internal codes):

<i>LABEL</i>	<i>DEFINITION</i>
CCOGIF	Provincial ccogif codes.

STORAGE & DISTRIBUTION INFORMATION

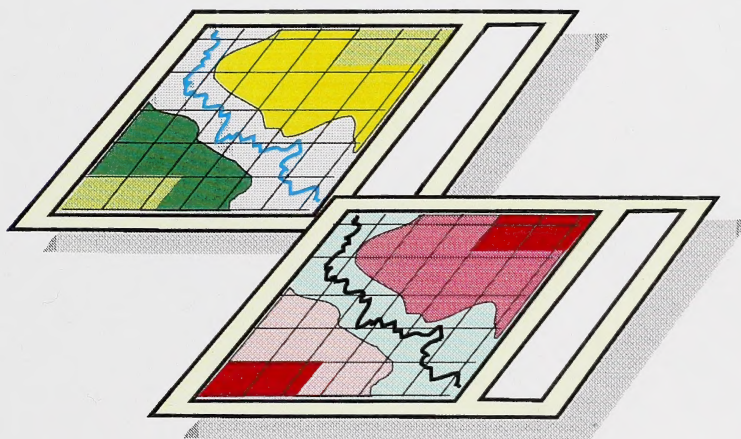
Storage:

Format: ARC/INFO Export Files

Approximate File Size (MB): 1

Development of a Satellite-based Ground Cover Classification Program for Alberta

Part of the Earth Observation Pilot Projects
Program (EOP3) Canada Centre for Remote Sensing



Study Area Maps

Report Prepared for:
Alberta Environmental Protection--
Resource Data Division
March 31, 1998

Report Prepared by:



and



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